# OBE Curriculum
# for the
# Undergraduate Program of the
# Department of Civil Engineering, BUET

**Department of Civil Engineering, BUET**
**November 2022**

***Published by:***
Department of Civil Engineering
Bangladesh University of Engineering and Technology
Dhaka 1000, Bangladesh.

## Editorial Committee:



DISCLAIMER
The Department of Civil Engineering and the Bangladesh University of Engineering and Technology (BUET) reserve the right to make, at any time without notice, changes in and addition any information or statement contained in this booklet. No responsibility will be accepted by the University or the Department of Civil Engineering for hardship or expenses encountered by its students or any other person or persons because of such changes

Version: 1.0, Dated: 14/11/2022

# PREFACE

It gives me great pleasure to publish the booklet on Outcome Based Education (OBE) course curriculum for undergraduate studies of the Department of Civil Engineering.

I would like to express my thanks and gratitude to all my colleagues of the Department. Members of the OBE Cell, specifically Dr. Ishtiaque Ahmed, Dr. Sheikh Mokhlesur Rahman, ands Ranjan Roy Bappy also deserve special thanks for their all-out effort and help in different stages of preparation of this booklet. I also thank the Lecturers of the department who helped to prepare the description of the courses.

This booklet presents the rules and regulations of the course system and course requirements and contents of the Department of Civil Engineering. Salient features of OBE-based curriculum is also included in the document. It is an essential companion for students of this Department as well as their advisers for smoothly carrying out their academic activities.

As with the practice of any Course System, it is likely that some of the rules and regulations published in this booklet may be modified in future. Students are, therefore, strongly advised to be in touch with their Advisers regarding modifications, if any, that may be introduced by the university.

It is hoped that the information provided in this booklet will be useful to the Advisers and undergraduate students of the Department of Civil Engineering.

Dhaka
November 2022

Dr. Md. Delwar Hossain
Professor and Head
Department of Civil Engineering,
BUET

# Table of Contents

# Outcome Based Education (OBE) Curriculum

Department of Civil Engineering
Bangladesh University of Engineering and Technology (BUET)

**PART A: Overview of the Program**

**1. Vision of BUET**

To be a leader in education, research and innovation in science, engineering and technology for sustainable future.

**2. Mission of BUET**

- To provide advanced transformative education, promote cutting-edge research, and foster innovation for producing competent graduates with ethical values.
- To create an inspiring, diverse and inclusive learning environment for planning, design and innovation.
- To enhance collaboration for improving knowledge and skill ensuring lifelong learning opportunity.
- To contribute towards reshaping for wellbeing of the society.

**3. Title of the Academic Program/Degree**

B.Sc. in Civil Engineering

**4. Name of the Department**

Department of Civil Engineering Bangladesh University of Engineering and Technology (BUET). In deciding the mission and vision, it was considered that BUET is a government funded institution and an apex technical university in the country. Also as the trend goes, every year the brightest student of the country take admission in this institution. Therefore, the mission and vision should reflect the nation’s expectation and also should be compatible with the potential of the students. With these considerations, the following mission and vision statements have been adopted respectively for the department.

**5. Vision of the Department**

To be the leading Civil Engineering program through quality education and research to enable innovation and excellence for addressing national and global challenges.

**6. Mission of the Department**

Provide high-quality education and pursue innovative research in Civil Engineering to ensure state-of-the-art solutions addressing the needs of society, profession and the nation. The mission statement can be divided into the following three major parts:

1. Educational Excellence
2. Advanced Research
3. Serving Society Needs

**7. Description of the Program**

Bangladesh University of Engineering and Technology (BUET) is known for its commitment to be the best when it comes to providing higher education in engineering and with it, comes one of the largest and oldest departments in the university – the Department of Civil Engineering. This department is known to provide the best curriculum for both the Undergraduate and Post-graduate students. This is possible due to the strong and highly cooperative faculty, homing about 50 PhD holders and other aspiring figures as teachers and mentors. This department is also providing the best labs for all the four majors: Structural Engineering, Geotechnical Engineering, Environmental Engineering and Transportation Engineering, kept under the supervision of senior Professors with the help of highly skilled and experienced lab assistants. This is a leading academic department in the country due to the outstanding graduates it is producing, its various research activities and its extensive involvements in countless important national development projects. The Alumni of this department are achieving great heights on a regular manner all around the country and abroad, which speak about the excellence of the Department of Civil Engineering.

## 8. Program Educational Objectives (PEOs)

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. PEOs are assessable based on the attributes and accomplishments of graduates, preferably those who have worked for 3 to 5 years after graduation. Each engineering program should have published PEOs that are clear, concise, assessable and realistic within the context of the available resources. The PEOs should be consistent with the vision and mission of the department offering the program. They should be supported by a curriculum and teaching-learning processes that lead to the attainment of these objectives. Justifications should be provided for how the curriculum and the outcomes contribute to the attainment of the PEOs. A process should be developed to assess the level of attainment of each PEO to evaluate the academic program’s effectiveness. Adequate evidence and documentation on the assessment of PEO attainment should be provided. The assessment tools should be indicated, and the way in which these tools are used should be explained. PEO assessment should lead to the periodic review of PEOs. Feedback from the various program stakeholders, including employers, alumni, students and faculty, should be considered during the review.

**Following are the five PEOs of the undergraduate Civil Engineering program:**

**PEO 1:** Graduates will attain a high level of technical expertise so that they are able to succeed in positions in civil engineering practice or research, and in other fields they choose to pursue.

**PEO 2:** Graduates will develop engineering designs that are based on sound principles and that consider functionality, aesthetics, safety, cost effectiveness and sustainability with professional ethics.

**PEO 3:** Graduates will practice lifelong learning through professional education.

**PEO 4:** Graduates will play a constructive role in addressing societal needs.

**PEO 5:** Graduates will be leaders, both in their chosen profession and in other activities.

## 9. Mapping mission of BUET with the mission of the Department

| | BUET Mission 1 | BUET Mission 2 | BUET Mission 3 | BUET Mission 4 |
|---|---|---|---|---|
| Department Mission 1 | ✓ | | | |
| Department Mission 2 | ✓ | | ✓ | |
| Department Mission 3 | | ✓ | | ✓ |

**10. Mapping missions of the Department with the PEOs**
Note: If required add /delete columns or rows

| PEOs | Mission Part 1 | Mission Part 2 | Mission Part 3 |
|---|---|---|---|
| PEO 1 | ✓ | ✓ | |
| PEO 2 | ✓ | ✓ | ✓ |
| PEO 3 | ✓ | | |
| PEO 4 | | | ✓ |
| PEO 5 | ✓ | | ✓ |

**11. Program Outcomes (PO)**

The teaching methods in the department revolve around the program outcome set by the department. The department follows the following program outcomes for its undergraduate programs:

**PO1-Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**PO2-Problem analysis:** Identify, formulate, research and analyze complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

**PO3- Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

**PO4- Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

**PO5-Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

**PO6-The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

**PO7-Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

**PO8-Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

**PO9-Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

**PO10- Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

**PO11-Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

**PO12-Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change

**12. Mapping of PEOs with POs**

Note: If required add /delete columns or rows

| POs | PEO 1 | PEO 2 | PEO 3 | PEO 4 | PEO 5 |
|---|---|---|---|---|---|
| PO 1 | ✓ | | | | |
| PO 2 | | ✓ | | | |
| PO 3 | | ✓ | | | |
| PO 4 | ✓ | | | | |
| PO 5 | ✓ | | | | |
| PO 6 | | | | ✓ | ✓ |
| PO 7 | | ✓ | ✓ | | |
| PO 8 | | ✓ | | | |
| PO 9 | | | | | ✓ |
| PO 10 | | | | ✓ | |
| PO 11 | | ✓ | | | |
| PO 12 | | | ✓ | | |

**PART B: Overview of the Curriculum**

**13. Structure of the Curriculum**

**13.1 Admission Requirements:**

Students are be admitted in undergraduate curricula in the Departments of Architecture, Urban and Regional Planning, Chemical Engineering, Civil Engineering, Water Resources Engineering, Computer Science and Engineering, Electrical and Electronic Engineering, Biomedical Engineering Mechanical Engineering, Industrial & Production Engineering, Materials and Metallurgical Engineering and Naval Architecture and Marine Engineering as per existing rules of the University. The Registrar's Office serve as the Admission Office.

**13.2 Duration of the Program:**

Years: 4 Semesters: 8

**13.3 Total minimum credit requirement to complete the program:**

Minimum credit hour requirements for the award of Bachelor's degree in engineering and architecture is proposed by the BUGS and approved by the Academic Council. However, at least 157 credit hours for engineering and 190 credit hours for architecture must be earned to be eligible for graduation, and this must include the specified core courses. Total credit hours requirement for B.Sc. in Civil Engineering degree is 161.

**13.4 Total class weeks in a Term:**

There will be two terms (Term I and Term II) in an academic year. The duration of each Term will be 18 weeks which will be used as follows:

| | |
|---|---|
| Classes | 14 weeks |
| Recess before term final exam | 02 weeks |
| Term final exam | 02 weeks |
| Total | 18 weeks |

**13.5 Minimum CGPA requirements for graduation:**

The minimum GPA requirement for obtaining a bachelor's degree in engineering, URP or architecture is 2.20.

**13.6 Maximum academic years of completion**: 04 Years

### 14. Course requirements for the B.Sc. Engg. (Civil) Degree Program

### 14.1 BASIC SCIENCES

| Requirement 12 credits (9+3) | | |
|---|---|---|
| Theoretical | | |
| *PHY 101 | Physical Optics, Waves and Oscillation, Heat and Thermodynamics | 3 credits |
| Phy 151 | Structure of Matter, Electricity and Magnetism and Modern Physics | 3 credits<br>Prereq. Phy 101 |
| * Chem 103 | Chemistry I | Chemistry I |
| Chem 105 | Chemistry II | 3 credits<br>Prereq. Chem 103 |
| Sessional | | |
| * Phy 102 | Physics Laboratory | 1.5 credits |
| * Chem 114 | Inorganic Quantitative Analysis | 1.5 credits |

* Compulsory

### 14.2 Mathematics

| Requirement 9 Credits (9+0) | | |
|---|---|---|
| Theoretical | | |
| * Math 137 | Differential and Integral Calculus, Matrices | 3 credits |
| * Math 139 | Differential Equations and Statistics | 3 credits |
| * Math 237 | Laplace Transform and Vector Analysis | 3 credits |

* Compulsory

### 14.3 Humanities and Social Sciences

| Requirement 9.5 Credits (8+1.5) | | |
|---|---|---|
| Theoretical | | |
| * Hum 185 | English | 2 credits |
| * Hum 217 | Engineering Economics | 2 credits |
| * Hum 353 | Accounting | 2 credits |
| Hum 355 | Sociology | 2 credits |
| Hum 375 | Government | 2 credits |
| Sessional | | |
| * Hum 274 | Developing English Language Skills | 1.5 credits |

* Compulsory

### 14.4 BASIC ENGINEERING

| Requirement 48 Credits (30+18) | | |
|---|---|---|
| Theoretical | | |
| * CE 101 | Analytic Mechanics | 3 credits |
| * CE 103 | Surveying | 4 credits |
| * EEE 165 | Basic Electrical Technology | 3 credits |
| * CE 201 | Engineering Materials | 3 credits |
| * CE 203 | Engineering Geology and Geomorphology | 3 credits |
| * CE 205 | Numerical Methods | 2 credits |
| * CE 207 | Applied Mathematics for Engineers | 3 credits |
| * WRE 211 | Fluid Mechanics | 3 credits |
| * CE 211 | Mechanics of Solids I | 3 credits<br>Prereq. CE 101 |

| | | |
|---|---|---|
| * CE 213 | Mechanics of Solids II | 3 credits<br>Prereq. CE 211 |
| Sessional | | |
| * CE 100 | Civil Engineering Drawing | 1.5 credits |
| * CE 102 | Computer Aided Drafting | 1.5 credits |
| * CE 104 | Practical Surveying | 1.5 credits |
| * Shop 132 | Workshop Sessional | 1.5 credits |
| * CE 200 | Details of Construction | 1.5 credits |
| * CE 202 | Materials Sessional | 1.5 credits |
| * WRE 212 | Fluid Mechanics Sessional | 1.5 credits |
| * CE 204 | Computer Programming Sessional | 1.5 credits |
| * CE 206 | Engineering Computation Sessional | 1.5 credits<br>Prereq. CE 204 |
| * CE 208 | Quantity Surveying | 1.5 credits |
| * CE 210 | Architectural, Engineering and Planning Appreciation | 1.5 credits |
| * CE 212 | Structural Mechanics and Materials Sessional | 1.5 credits |
| | | |

* Compulsory

**14.5 CIVIL ENGINEERING PRACTICE**

| Requirement 17.0 Credits (10+7.0) | | |
|---|---|---|
| Theoretical | | |
| * CE 301 | Professional Practices and Communication | 3 credits |
| * CE 401 | Project Planning and Construction Management | 4 credits |
| CE 403 | Sustainability of Development Projects | 3 credits |
| CE 405 | Business and Career Development | 3 credits |
| CE 407 | Principles of Project Finance | 3 credits |
| Sessional | | |
| * CE 300 | Professional Training in Civil Engineering | 1.0 credits |
| * CE 302 | Professional Practices and Communication Sessional | 1.5 credits |
| * CE 404 | Capstone Project | 4.5 credits |

* Compulsory

**14.6 STRUCTURAL ENGINEERING**

| Minimum Requirement 20.5 Credits (16+4.5) | | |
|---|---|---|
| Theoretical | | |
| * CE 311 | Structural Analysis | 4 credits<br>Prereq. CE 213 |
| * CE 315 | Design of Concrete Structures I | 3 credits |
| * CE 317 | Design of Concrete Structures II | 3 credits<br>Prereq. CE 315 |
| * CE 319 | Design of Steel Structures | 3 credits |
| * CE 411 | Analysis of Indeterminate Structures | 3 credits<br>Prereq. CE 311 |
| CE 413 | Introduction to Steel Concrete Composite Structures | 2 credits |
| CE 415 | Prestressed Concrete | 2 credits |
| CE 417 | Design of Concrete Structures III | 2 credits |
| CE 419 | Introduction to Finite Element Method | 2 credits |
| CE 421 | Dynamics of Structures | 2 credits |

| | | |
|---|---|---|
| Sessional | | |
| * CE 316 | Bridge Design Sessional | 1.5 credits |
| * CE 320 | Steel Structures Design Sessional | 1.5 credits |
| * CE 410 | Building Design Sessional | 1.5 credits |
| CE 400 | Undergraduate Thesis | 3.0 credits |
| | | |

* Compulsory

**14.7 ENVIRONMENTAL ENGINEERING**

| | | |
|---|---|---|
| Minimum Requirement 20.5 Credits (16+4.5) | | |
| Theoretical | | |
| * CE 331 | Environmental Engineering I | 3 credits |
| | | |
| * CE 333 | Environmental Engineering II | 4 credits |
| CE 433 | Solid and Hazardous Waste Management | 2 credits |
| CE 435 | Environmental Pollution Management | 2 credits |
| CE 437 | Basic Environmental Management | 2 credits |
| Sessional | | |
| * CE 332 | Environmental Engineering Laboratory | 1.5 credits |
| CE 400 | Undergraduate Thesis | 3.0 credits |
| | | |

* Compulsory

**14.8 GEOTECHNICAL ENGINEERING**

| | | |
|---|---|---|
| Minimum Requirement 8.5 Credits (7+1.5) | | |
| Theoretical | | |
| * CE 341 | Principles of Soil Mechanics | 4 credits Prereq. CE 203 |
| * CE 441 | Foundation Engineering | 3 credits |
| CE 443 | Earth Retaining Structures | 2 credits |
| CE 445 | Elementary Soil Dynamics | 2 credits |
| CE 447 | Soil-water Interaction | 2 credits |
| Sessional | | |
| * CE 342 | Geotechnical Engineering Laboratory | 1.5 credits |
| CE 400 | Undergraduate Thesis | 3.0 credits |
| | | |

* Compulsory

**14.9 TRANSPORTATION ENGINEERING**

| | | |
|---|---|---|
| Minimum Requirement 8.5 Credits (7+1.5) | | |
| Theoretical | | |
| * CE 351 | Transportation Engineering I: Transportation Planning & Traffic Engineering | 3 credits |
| * CE 451 | Transportation Engineering II: Pavement Design and Railway Engineering | 4 credits |
| CE 453 | Transportation Engineering III: Traffic Engineering Design and Management | 2 credits |
| CE 455 | Transportation Engineering IV: Pavement Management, Drainage and Airport | 2 credits |
| CE 457 | Transportation Engineering V: Urban Transportation Planning and Management | 2 credits |

| | | |
|---|---|---|
| Sessional | | |
| CE 400 | Undergraduate Thesis | 3.0 credits |
| | | |
| * CE 452 | Transportation Engineering Sessional I: Highway Materials and Traffic Engineering Design | 1.5 credits |

* Compulsory

**14.10 WATER RESOURCES ENGINEERING**

| Minimum Requirement 8.5 Credits (7+1.5) | | |
|---|---|---|
| Theoretical | | |
| * WRE 311 | Open Channel Flow | 4 credits |
| * WRE 451 | Hydrology, Irrigation and Flood Management | 3 credits |
| Sessional | | |
| * WRE 312 | Open Channel Flow Sessional | 1.5 credits |

* Compulsory

**14.11 Summary of the Requirements for B.Sc. Engg. (Civil) Degree**

| Courses | Requirements (Total Credits to be Offered) |
|---|---|
| A. Natural Science | 12 (15) |
| B. Mathematics | 9 (9) |
| C. Humanities and Social Sciences | 9.5 (11.5) |
| D. Basic Engineering | 48 (48) |
| E. Civil Engineering Practice | 12.5 (18.5) |
| F. Structural Engineering | 20.5 (38) |
| G. Environmental Engineering | 8.5 (22) |
| H. Geotechnical Engineering | 8.5 (22) |
| I. Transportation Engineering | 8.5 (22) |
| J. Water Resources Engineering | 8.5 (18.5) |
| Total | 144.5 |
| UG Thesis | 3.0 |
| Capstone Project | 4.5 |
| Optional Courses**: Theory | 8.0 (38 in F to J, Max. 4 from each division) |
| **Grand Total** | 161 |

** Students specializing in an optional group, such as Structural, Geotechnical, Environmental and Transportation, shall take thesis, capstone project, and at least two optional theory courses from that group and two more optional theory courses from any other group.

## 15. Courses offered in Different Term

| Level | Term | Course No. | Course Title | Credit Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 1 | I | CE 101 | Analytic Mechanics | 3.00 | C | |
| | | Chem 103 | Chemistry I | 3.00 | C | |
| | | Math 137 | Differential and Integral Calculus, Matrices | 3.00 | C | |
| | | Phy 101 | Physical Optics, Waves and Oscillation, Heat and Thermodynamics | 3.00 | C | |
| | | Hum 355 | Sociology | 2.00 | O | Select one |
| | | Hum 375 | Government | 2.00 | O | |
| | | CE 100 | Civil Engineering Drawing | 1.50 | C | |
| | | Chem 114 | Inorganic Quantitative Analysis | 1.50 | C | |
| | | Phy 102 | Physics Laboratory | 1.50 | C | |
| | | | Total | **18.50** | | |

C: Compulsory O: Optional

| Level | Term | Course No. | Course Title | Credit Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 1 | II | CE 103 | Surveying | 4.00 | C | |
| | | EEE 165 | Basic Electrical Technology | 3.00 | C | |
| | | Hum 185 | English | 2.00 | C | |
| | | Math 139 | Differential Equations and Statistics | 3.00 | C | |
| | | Chem 105 * | Chemistry II | 3.00 | O | Select one |
| | | Phy 151 * | Structure of Matter, Electricity and Magnetism and Modern Physics | 3.00 | O | |
| | | CE 102 | Computer Aided Drafting | 1.50 | C | |
| | | CE 104 | Practical Surveying | 1.50 | C | |
| | | HUM 274 | Developing English Language Skills | 1.50 | C | |
| | | Shop 132 | Workshop Sessional | 1.50 | C | |
| | | | Total | **21.00** | | |

C: Compulsory O: Optional
*: Registration of this course requires obtaining minimum F grade in its pre-requisite course

| Level | Term | Course No. | Course Title | Credit Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 2 | I | CE 201 | Engineering Materials | 3.00 | C | |
| | | CE 203 | Engineering Geology and Geomorphology | 3.00 | C | |
| | | CE 211 * | Mechanics of Solids I | 3.00 | C | |
| | | Hum 353 | Accounting | 2.00 | C | |
| | | Math 237 | Laplace Transform and Vector Analysis | 3.00 | C | |
| | | CE 200 | Details of Construction | 1.50 | C | |
| | | CE 202 | Materials Sessional | 1.50 | C | |
| | | CE 204 | Computer Programming Sessional | 1.50 | C | |
| | | CE 210 | Architectural, Engineering and Planning Appreciation | 1.50 | C | |
| | | | Total | **20.00** | | |

C: Compulsory
*: Registration of this course requires obtaining minimum F grade in its pre-requisite course

| Level | Term | Course No. | Course Title | Credit Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 2 | II | CE 205 | Numerical Methods | 2.00 | C | |
| | | CE 213 * | Mechanics of Solids II | 3.00 | C | |
| | | Hum 217 | Engineering Economics | 2.00 | C | |
| | | CE 207 | Applied Mathematics for Engineers | 3.00 | C | |
| | | WRE 211 | Fluid Mechanics | 3.00 | C | |
| | | CE 206 * | Engineering Computation Sessional | 1.50 | C | |
| | | CE 208 | Quantity Surveying | 1.50 | C | |
| | | CE 212 | Structural Mechanics and Materials Sessional | 1.50 | C | |
| | | WRE 212 | Fluid Mechanics Sessional | 1.50 | C | |
| | | | Total | **19.00** | | |

C: Compulsory
*: Registration of this course requires obtaining minimum F grade in its pre-requisite course

| Level | Term | Course No. | Course Title | Credit Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 3 | I | CE 301 | Professional Practices and Communication | 3.00 | C | |
| | | CE 311 * | Structural Analysis | 4.00 | C | |
| | | CE 315 | Design of Concrete Structures I | 3.00 | C | |
| | | CE 331 | Environmental Engineering I | 3.00 | C | |
| | | CE 341 * | Principles of Soil Mechanics | 4.00 | C | |
| | | CE 302 | Professional Practices and Communication Sessional | 1.50 | C | |
| | | CE 332 | Environmental Engineering Laboratory | 1.50 | C | |
| | | CE 342 | Geotechnical Engineering Laboratory | 1.50 | C | |
| | | | Total | **21.50** | | |

C: Compulsory
*: Registration of this course requires obtaining minimum F grade in its pre-requisite cours

| Level | Term | Course No. | Course Title | Credit Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 3 | II | CE 317 * | Design of Concrete Structures II | 3.00 | C | |
| | | CE 319 | Design of Steel Structures | 3.00 | C | |
| | | CE 333 | Environmental Engineering II | 4.00 | C | |
| | | CE 351 | Transportation Engineering I: Transportation Planning & Traffic Engineering | 3.00 | C | |
| | | WRE 311 | Open Channel Flow | 4.00 | C | |
| | | CE 300 | Professional Training in Civil Engineering | 1.00 | C | |
| | | CE 316 | Bridge Design Sessional | 1.50 | C | |
| | | CE 320 | Steel Structures Design Sessional | 1.50 | C | |
| | | WRE 312 | Open Channel Flow Sessional | 1.50 | C | |
| | | | Total | **22.50** | | |

C: Compulsory
*: Registration of this course requires obtaining minimum F grade in its pre-requisite course

| Level | Term | Course No. | Course Title | Credi t Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 4 | I | CE 401 | Project planning and Construction Management | 4.00 | C | |
| | | CE 411 * | Analysis of Indeterminate Structures | 3.00 | C | |
| | | CE 441 | Foundation Engineering | 3.00 | C | |
| | | CE 451 | Transportation Engineering II: Pavement Design and Railway Engineering | 4.00 | C | |
| | | WRE 451 | Hydrology, Irrigation and Flood Management | 3.00 | C | |
| | | CE 452 | Transportation Engineering Sessional I: Highway Materials and Traffic Engineering Design | 1.50 | C | |
| | | CE 400 ** | Undergraduate Thesis | 1.50 | C | |
| | | CE 404 ** | Capstone Project | 1.50 | C | |
| | | CE 410 | Building Design Sessional | 1.50 | C | |
| | | | Total | **23.00** | | |

C: Compulsory
*: Registration of this course requires passing of its pre-requisite course
**: To register in a division of specialization from Structural, Environmental, Geotechnical, and Transportation Engineering.

| Level | Term | Course No. | Course Title | Credit Hours | Status of Course | Selection Basis/ Remarks |
|---|---|---|---|---|---|---|
| 4 | II | CE 403 | Sustainability of Development Projects | 3.00 | O | Select one |
| | | CE 405 | Business and Career Development | 3.00 | O | |
| | | CE 407 | Principles of Project Finance | 3.00 | O | |
| | | CE 400 ** | Undergraduate Thesis | 1.50 | C | |
| | | CE 404 ** | Capstone Project | 3.00 | C | |
| | | CE 413 | Introduction to Steel-Concrete Composite Structures | 2.00 | O | Select two (Structure) |
| | | CE 415 | Prestressed Concrete | 2.00 | O | |
| | | CE 417 | Design of Concrete Structures III | 2.00 | O | |
| | | CE 419 | Introduction to Finite Element Method | 2.00 | O | |
| | | CE 421 | Dynamics of Structures | 2.00 | O | |
| | | CE 433 | Solid and Hazardous Waste Management | 2.00 | O | Select two (Environment) |
| | | CE 435 | Environmental Pollution Management | 2.00 | O | |
| | | CE 437 | Basic Environmental Management | 2.00 | O | |
| | | CE 443 | Earth Retaining Structures | 2.00 | O | Select two (Geotechnical) |
| | | CE 445 | Elementary Soil Dynamics | 2.00 | O | |
| | | CE 447 | Soil-water Interaction | 2.00 | O | |
| | | CE 453 | Transportation Engineering III: Traffic Engineering Design and Management | 2.00 | O | Select two (Transport) |
| | | CE 455 | Transportation Engineering IV: Pavement Management, Drainage and Airport | 2.00 | O | |
| | | CE 457 | Transportation Engineering V: Urban Transportation Planning and Management | 2.00 | O | |
| | | | Total | **15.50** | | |

C: Compulsory O: Optional
*: Registration of this course requires passing of its pre-requisite course
**: To register in division of specialization from Structural, Environmental, Geotechnical, and Transportation Engineering.

## 16. Course wise Content as approved by the Academic Council

### 16.1 Courses Offered by the Department of Civil Engineering (For Civil Engineering students)

**CE 100: Civil Engineering Drawing**
**1.50 credits, 3 hrs/week**

Lines and lettering; plane geometry: drawing of linear and curved geometric figures, e.g. pentagon, hexagon, octagon, ellipse, parabola, hyperbola; solid geometry: concept of isometric view and oblique view, theory of projections; drawing of isometric view of 3d objects such as cube, prism, pyramid, cone and cylinder; projections of cube, prism, cone, cylinder; developments of cube, pyramid, cone, cylinder; plan, elevations and sections of one storied and duplex building.

**CE 101: Analytic Mechanics**
**3.00 credits, 3 hrs/week**

Coplanar and non-coplanar force systems; moments; analyses of two- dimensional frames and trusses; friction; flexible chords; centroids of lines, areas and volumes; moments of inertia of areas and masses; plane motion; principles of work and energy; impulse and momentum; virtual work principle for rigid bodies.

**CE 102: Computer Aided Drafting**
**1.50 Credits, 3 hrs/week**

Introduction to computer usage; introduction to CAD packages and computer aided drafting: drawing editing and dimensioning of simple objects; plan, elevations and sections of multi-storied buildings; reinforcement details of beams, slabs, stairs etc; plan and section of septic tank; detailed drawings of roof trusses; plans, elevations and sections of culverts, bridges and other hydraulic structures; drawings of building services. **CE 103: Surveying**
**4.00 credits, 4 hrs/week**

Reconnaissance survey; linear measurements; traverse survey; triangulation, leveling and contouring; calculation of areas and volumes; problems on heights and distances; curves and curve ranging, transition curve, vertical curves; tacheometry: introduction, principles and problems on tacheometry; astronomical surveying: definition, instruments, astronomical corrections, systems of time; photogrammetry: introduction of terrestrial photography, aerial photography, reading of photo mosaic, scale; project surveying; errors in surveying; remote sensing; introduction to geographic information system (GIS) and global positioning system (GPS).

**CE 104: Practical Surveying**
**1.50 credits, 3 hrs/week**

Linear and angular measurement techniques; traverse surveying; leveling and contouring; curve setting; tacheometry; project surveying; modern surveying equipment and their applications.

**CE 200: Details of Constructions**
**1.50 credits, 3 hrs/week**

Types of building, components of a building, design loads, framed structure and load bearing wall structure; foundations: shallow foundation and deep foundation, site exploration, bearing capacity of soil, standard penetration test; brick masonry: types of brick, bonds in brickwork, supervision of brickwork, brick laying tools, defects and strength on brick masonry, typical structures in brickwork, load bearing and non-load bearing walls, cavity walls, partition walls; lintels and arches: different types of lintels and arches, loading on lintels, construction of arches; stairs: different types of stairs, floors: ground floors and upper floors; roofs and roof coverings; shoring; underpinning; scaffolding and formwork; plastering, pointing, painting; distempering and white washing; cement concrete construction; sound insulation: acoustics; thermal insulation; house plumbing: water supply and wastewater drainage.

**CE 201: Engineering Materials**
**3.00 credits, 3 hrs/week**

Properties and uses of aggregates, brick, cement; sand, lime, mortars; concrete; concrete mix design; wood structures and properties; shrinkage and seasoning; treatment and durability; mechanical properties; wood products; advanced fiber reinforced polymer (FRP) composites and its application to civil engineering; reinforcement types, basic property of FRP composites and available FRP composite products; definition of stress and strain; plane stress and strain condition; identification of strain components of elastic, elasto-plastic and elasto-visco-plastic materials; time dependent strain response of these materials due to different types of loadings; mathematical and simple rheological modeling for prediction of creep behavior; ferrocement: advantages and uses; corrosion and prevention of steel in RC structures, offshore structures and ground applications.

**CE 202: Materials Sessional**
**1.50 credits, 3 hrs/week**

General discussion on preparation and properties of concrete, test for specific gravity, unit weight, voids and bulking of aggregates; moisture content and absorption of coarse and fine aggregates; normal consistency, initial setting time, soundness and fineness test of cement; direct tensile and compressive strengths of cement mortar; gradation of coarse and fine aggregates; design and testing of a concrete mix, sampling and testing of bricks for absorption, unit weight, efflorescence and compressive strength.

**CE 203: Engineering Geology and Geomorphology**
**3.00 credits, 3 hrs/week**

Minerals; identification of minerals, common rock forming minerals; physical properties of minerals; mineraloids rocks; types of rocks, cycle of rock change; earthquake and seismic map of Bangladesh.

Structural geology; faults; types of faults; fold and fold type; domes; basins; erosional process; quantitative analysis of erosional land forms. Channel development; channel widening; valley shape; stream terraces; alluvial flood plains; deltas and alluvial fans; channel morphology; channel patterns and the river basin; geology and geomorphology of Bangladesh.

**CE 204: Computer Programming Sessional**
**1.50 credits, 3 hrs/week**

Programming concepts and algorithms; internal representation of data; elements of structured programming language: data types, operators, expressions, control structures, functions, pointers and arrays, input and output; concept of Object Oriented Programming (OOP): encapsulation, inheritance, polymorphism and abstraction.

**CE 205: Numerical Methods**
**2.00 credits, 2 hrs/week**

Systems of linear algebraic equations; interpolation and curve fitting; roots of equations; numerical differentiation; numerical integration; initial value problems; two-point boundary value problems; finite differences.

**CE 206: Engineering Computation Sessional**
**1.50 credits, 3 hrs/week Prereq. CE 204**

Introduction to hi-level computational programming tools; application to numerical analysis: basic matrix computation, solving systems of linear equations, non-linear equations, differential equations, interpolation and curve fitting, numerical differentiation, numerical integration; application to engineering problems: solving problems related to mechanics, numerical solution of equation of motion etc.

**CE 207: Applied Mathematics for Engineers**
**3.00 credits, 3 hrs/week**

Review of differential equations; power series solution of differential equations and their applications: Frobenius method, Legendre’s polynomials, gamma function, Bessel’s function; integral form of differential equation and its application to engineering problem solving.

Fourier series and its properties, application to engineering problem solving; Fourier integral; Fourier transforms and their uses in solving boundary value problems.

Application of statistical methods to engineering problems: Random variables; discrete and continuous probability distributions; functions of random variables and derived distributions; expectation and moments of random variables; point estimation of distribution parameters: methods of moments and maximum likelihood, Bayesian analysis; confidence intervals; hypothesis tests; nonparametric statistical tests; simple and multiple linear regression and model selection; uncertainty and reliability analysis; project level decision making and quality control.

**CE 208: Quantity Surveying**
**1.50 credits, 3 hrs/week**

Earthwork excavation for roadway, earthwork computation from spot levels; estimation for residential building: estimation of slab, beam, column, footing; analysis of rates, specifications, costing of residential building; estimation and costing of septic tank; estimation and costing of underground water reservoir; estimation and costing of retaining wall; estimation and costing of slab culvert; estimation and costing of bridges; highways construction; estimation of steel truss; computer aided quantity estimation; construction site survey and estimation.

**CE 210: Architectural, Engineering and Planning Appreciation**
**1.50 credits, 3 hrs/week**

Appreciation of architecture, mechanical engineering, urban and regional planning; environmental issues.

**CE 211: Mechanics of Solids I**
**3.00 credits, 3 hrs/week Prereq. CE 101**

Concepts of stress and strain, generalized Hooke's law; deformations due to tension, compression and temperature change; frame statics: reactions, axial force, shear force and bending moments; axial force, shear force and bending moment diagrams of beams using method of section and summation approach; elastic analysis of circular shafts in torsion, solid noncircular and thin walled tubular members subjected to torsion, flexural and shear stresses in beams; shear center; closely coiled helical springs.

**CE 212: Structural Mechanics and Materials Sessional**
**1.50 credits, 3 hrs/week**

Tension, direct shear and impact tests of mild steel specimen; slender column test; static bending test; hardness test of metals; helical spring test; determination of shear centre; study of structural models: truss, beam frame.

**CE 213: Mechanics of Solids II**
**3.00 credits, 3 hrs/week Prereq. CE 211**

Symmetric and unsymmetrical bending of beams; stresses due to axial load and bending; stress transformation, Mohr's circle of stresses; beam deflection by direct integration and moment area method; elastic buckling of columns; elastic strain energy; cable theorem and cable supported structures, thin-walled pressure vessels.

**CE 300: Professional Training in Civil Engineering**
**1.00 credits, 2 hrs/week**

Involvement as a trainee in a Civil Engineering related industry/ projects/ firms to gather knowledge on state-of-the-art practices of Civil Engineering.

**CE 301: Professional Practices and Communication**
**3.00 credits, 3 hrs/week**
Project, its characteristic feature, project life cycle; type of contracts; procurement regulations and law; documents for procurement of works, goods and services and their application; contract risk and contract responsibility; insurances; tender procedure; claims, disputes and arbitration procedure; measures for reducing fiduciary risks.

Introduction to communication concepts, modes of communication, methods of effective communication; writing reports; oral presentation of reports; writing proposals; preparing effective business messages; conducting meetings; strategies for effective speaking and successful inter personal communication; job application process, interviews and follow-ups; an introduction to the code of ethics for engineers.

**CE 302: Professional Practices and Communication Sessional**
**1.50 credits, 3 hrs/week**
Application of communication theory and professional practice approaches in a controlled class room environment; this may include case study analysis, role playing, preparing small reports and proposals, class room presentations and individual reports etc.

**CE 311: Structural Analysis**
**4.00 credits, 4 hrs/week Prereq. CE 213**

Stability and determinacy of structures; Analysis of statically determinate frames, trusses and arches; Influence lines; Moving loads on beams, frames and trusses; Wind and earthquake loads, code provisions.

Approximate analysis of statically indeterminate structures: Mill bents, braced trusses; Portal method, cantilever method and vertical load analysis of multi storied building frames; building drift.

Deflection of beams, trusses and frames by virtual work method; Approximate analysis of suspension bridges.

**CE 315: Design of Concrete Structures I**
**3.00 credits, 3 hrs/week**

Fundamental behavior of reinforced concrete and loads on structure; introduction to strength design and alternate design methods; flexural design of beams (singly reinforced, doubly reinforced, T-beam) using strength design method; shear, diagonal tension and torsion of beams; bond and anchorage of reinforcement and its detailing; design of one- way slabs; design of two-way edge supported slabs.

**CE 316: Bridge Design Sessional**
**1.50 credits, 3 hrs/week**

Design and detailing of a slab bridge; design and detailing of a balanced cantilever bridge; design and detailing of a PC Girder Bridge.

**CE 317: Design of Concrete Structures II**
**3.00 credits, 3 hrs/week Prereq. CE 315**

Design of column supported slabs; introduction to floor systems; structural forms; design of columns under uniaxial and biaxial loading, introduction to slender column; structural design of footings, pile caps; seismic detailing; shear wall subjected to axial load and flexure; introduction to prestressed concrete; analysis and preliminary design of prestressed beam.

**CE 319: Design of Steel Structures**
**3.00 credits, 3 hrs/week**

Behavioral principles and design of structural steel; design of tension members, residual stress; bolted and welded connections; compression members; local buckling, effective length; flexural members; lateral torsional buckling, flexure and shear strength, point loads on beam, design for deflection.

Introduction to beam-columns; non-sway frames.

Connection design: simple connection, moment connection, column bases; introduction to floor systems for steel buildings.

**CE 320: Steel Structures Design Sessional**
**1.50 credits, 3 hrs/week**

Analysis and design of low rise moment frame building for gravity and wind loads; design of members, connections and columns bases.

**CE 331: Environmental Engineering I**
**3.00 credits, 3 hrs/week**

Introduction to Environmental Engineering: ecology and environment; climate change; biodiversity; energy and environment.

Water Supply Engineering: introduction; water supply scenario in Bangladesh and SDG targets; water demands; water supply sources; ground water exploration: aquifer properties and ground water flow, well hydraulics, water well design, drilling, construction and maintenance; water demand for rural communities; shallow hand tubewells, deep tubewells, deep set pumps, rainwater harvesting, and alternative water supplies for problem areas.

Surface water collection and transportation; head works; pumps and pumping machineries; water distribution systems; analysis and design of distribution network; fire hydrants; water meters; leak detection; unaccounted for water.

Water quality requirements; water treatment: plain sedimentation, coagulation, flocculation, filtration, disinfection; miscellaneous treatment methods; low cost treatment methods for rural communities; water safety plans.

**CE 332: Environmental Engineering Laboratory**
**1.50 credits, 3 hrs/week**

Water and wastewater sampling techniques, sample preservation, physical, chemical and biological tests of water and wastewater; breakpoint chlorination, alum coagulation, sampling and laboratory analysis of air, sampling and laboratory analysis of soil and solid waste.

**CE 333: Environmental Engineering II**
**4.00 credits, 4 hrs/week**

Introduction to waste management: liquid waste, solid waste, air and noise pollution.

Wastewater Engineering: introduction; estimation of wastewater; wastewater collection systems; hydraulics of sewer; design, construction and maintenance of sanitary sewer and storm drainage system; sewer appurtenances.

Wastewater characteristics; microbiology of wastewater; wastewater treatment and disposal; sludge treatment and disposal.

Sanitation and health; sanitation coverage in Bangladesh and SDG targets; onsite sanitation system including fecal sludge management (FSM), pour-flush toilets, septic tank system, Anaerobic Baffled Reactor (ABR); decentralized wastewater treatment systems (DEWATS).

Plumbing system.

Sustainability of water and sanitation services, introduction to EIA.

**CE 341: Principles of Soil Mechanics**
**4.00 credits, 4 hrs/week Prereq. CE203**

Introduction to geotechnical engineering; formation, type and identification of soils; soil composition; soil structure and fabric; index properties of soils; engineering classification of soils; soil compaction; principles of total and effective stresses; permeability and seepage; stress-strain-strength characteristics of soils; compressibility and settlement behavior of soils; lateral earth pressure; stress distribution.

**CE 342: Geotechnical Engineering Laboratory**
**1.50 credits, 3 hrs/week**

Field identification tests of soils; grain size analysis by sieve and hydrometer; specific gravity test; Atterberg limits test; permeability tests; unconfined compression test; compaction test; relative density test; direct shear tests; consolidation tests; test of geotextiles.

**CE 351: Transportation Engineering I: Transportation Planning and Traffic Engineering**
**3.00 credits, 3 hrs/week**

Transportation engineering, transportation functions; transportation systems, functional components, factors in transportation development, transportation modes, public transportation, emerging modes; intelligent transportation system: components and applications; transport planning: concepts, scope and hierarchy, process, goals and objectives, inventories, socio-economic activities, land use-transport interaction, travel demand forecasting; road safety and accident analysis.

Geometric design of highways: design controls and criteria, cross sectional elements, alignment, sight distance, intersection and interchange layouts, planning and design of bicycle and pedestrian facilities; traffic engineering: fundamentals of traffic engineering, vehicle and traffic characteristics, traffic control devices and systems, traffic studies, planning and design of parking facilities, roadway lighting; transportation in Bangladesh: transportation modes and networks, constraints and challenges, transport demand and modal share, road classification and design standards.

**CE 400: Undergraduate Thesis**
**3.00 credits, 6 hrs/week**

Experimental and theoretical investigation of various topics in structural engineering, environmental engineering, transportation engineering and geotechnical engineering. Individual or group study of one or more topics from any of the above fields. The students will be required to present and submit thesis at the end of the work.

**CE 401: Project Planning and Construction Management**
**4.00 credits, 4 hrs/week**

Project evaluation: cash flow and net present value, perpetuities and annuities, internal rate of return, payback period, benefit-cost ratio, real and nominal interest rate, capital budgeting, risk versus return, capital asset pricing model and project cost of capital, financial and economic feasibility, sensitivity analysis.

Leading and managing teams: human resource management, dysfunctions in teams, team development, conflict management, leading teams, self-managing teams, decision making in teams, case study.

Project operation management: project as a process, inventory management, economic order quantity, demand forecasting – newsvendor model, labour and plant management – line balancing, legal and ethical issues in project – case study, environmental regulations, procurement – value for money (VfM).

Project planning and control: planning and scheduling, PERT, CPM, resource scheduling, linear programming and application.
Construction management: principles, project organization, methods and practices, technology, management of materials and equipment, site management, contracts and specifications, inspection and quality control, quality assurance, safety, economy.
**CE 403: Sustainability of Development Projects**

**3.00 credits, 3 hrs/week**

Environment and sustainable development; sustainable development goals (SDGs); economics and social structure; development and economic growth; socio-economic indicators; concept of human development, human development index; gender related human development index; human poverty and human poverty index; poverty reduction strategies in Bangladesh.

Socio-economic aspects of development projects; human interest related aspects; land loss, land use and land ownership patterns; population displacement; resettlement and rehabilitation strategy; inequalities in distribution of benefits and losses.

Socio-economic impact assessment approach; socio-economic survey; case studies.

**CE 404: Capstone Project**
**4.50 credits, 9 hrs/week**

Planning, analysis and design of an integrated civil engineering project with emphasis on structural engineering/ environmental engineering/ transportation engineering/ geotechnical engineering specialization. Students shall work in teams to apply civil engineering theories, methodologies, and skills to assess the technical, environmental, and social feasibility of the project including design and cost estimation. Student shall engage their diverse civil engineering and cross- disciplinary knowledge to prepare plans and specifications of the project including Bill of Quantity (BoQ) and tender documents.

Students shall present their projects and submit project reports at the end of the work.

**CE 405: Business and Career Development**
**3.00 credits, 3 hrs/week**

Understanding and managing organizations: structural, human resource, political, symbolic fames.

Developing strategy and competitive advantage: industry analysis, complementor, understanding value, strategy development.

Managing disruptive innovations - understanding innovation, organizing for innovation.

Marketing management: capturing market insight, connecting with customers, communicating value, building strong brands.

Career development: definition of career, value of career development, external and internal dimensions of career, career stages, preparing for job search, networking, interview, career fairs, internship, building online brand, preparing resume, civil engineering careers of the future and vision for civil engineering.

Becoming an entrepreneur: identify opportunity, developing business model, designing value Proposition, Lean Startups, Hypothesis Testing, Sales & Marketing.

**CE 407: Principles of Project Finance**
**3.00 credits, 3 hrs/week**

Fundamental aspects of project finance, project development and management, working with lenders, project agreement, commercial risks, regulatory and political risks, financial structuring, financial model, financial support, documentation.

**CE 410: Building Design Sessional**
**1.50 credits, 3 hrs/week**

Analysis and design of low rise RC moment frame buildings for wind and low seismic application; multi-storied RC buildings with shear wall and mat foundation for wind and high seismic application; reinforcement design and detailing at joints.

**CE 411: Analysis of Indeterminate Structures**
**3.00 credits, 3 hrs/week Prereq. 311**

Stiffness properties of beam elements; Moment distribution and flexibility/consistent deformation approaches in solving statically indeterminate structures e.g. beams, frames and trusses; matrix stiffness method in analyzing statically indeterminate beams, plane frames, grids and trusses subject to loads, temperature changes, support settlements etc.; computer application oriented direct stiffness method; influence lines of statically indeterminate structures.

**CE 413: Introduction to Steel-Concrete Composite Structures**
**2.00 credits, 2 hrs/week**

Introduction to composite structures, advantages of composite construction; behaviour of different types of composite columns, axial load capacity and interaction diagram for composite columns.

Composite floor system: details of composite deck and shear connectors.

Elastic and plastic analysis of composite beams; design of composite beams for serviceability and strength limit states.

**CE 415: Prestressed Concrete**
**2.00 credits, 2 hrs/week**

Prestressed Concrete: concepts of prestressing; materials; anchorage systems; loss of prestress; analysis of sections for flexure, shear, bond and bearing; analysis of end block and composite sections; beam deflections; cable layout; partial prestress.

Design of prestressed concrete beams for simple and continuous spans; ideas about use of AASHTO – PCI sections for standard spans; design considerations for prestressed concrete pipes, piles, poles and railway sleepers.

**CE 417: Design of Concrete Structures III**
**2.00 credits, 2 hrs/week**

Analysis and design for torsion; design of one way and two way joist slabs with or without beam on the column line; design and detailing of lateral load resisting components: shear wall, lift cores, diaphragm etc.; design of reinforcement at joints.

**CE 419: Introduction to Finite Element Method**
**2.00 credits, 2 hrs/week**

Introduction to finite element method as applied to stress analysis problems; basic equations in elasticity, matrix displacement formulation, element shapes, nodes, nodal unknowns and coordinate system, shape functions, strain displacement matrix, methods for assembling stiffness equations e.g. direct approach, Galerkin's method, virtual work method, principle of minimum potential energy; introduction to isoparametric formulation; discritization of a structure and mesh refinement, one dimensional stress-deformation and two dimensional plane stress and plane strain analysis of stress- deformation problems; numerical integration and computer application.

**CE 421: Dynamics of Structures**
**2.00 credits, 2 hrs/week**

Single degree of freedom system, free vibration response; response to harmonic, impulse and general dynamic loading; numerical evaluation of dynamic response; earthquake response of linear system; two degrees of freedom system; response spectrum analysis.

**CE 433: Solid and Hazardous Waste Management**
**2.00 credits, 2 hrs/week**

Solid Waste Management: sources and types of solid wastes; physical and chemical properties of solid wastes; solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer stations and transport; ultimate disposal methods; resources and energy recovery options; 3R strategy; Solid waste management policy in Bangladesh.

Hazardous Waste Management: identification, sources and characteristics of hazardous wastes; hospital waste management practices; legal aspects; auditing and prevention; methods of treatment and disposal – physical, chemical, biological and thermal treatment; stabilization and solidification, engineering storage, incineration, landfill and deep burial.

**CE 435 Environmental Pollution Management**
**2.00 credits, 2 hrs/week**

Water pollution: sources and types of pollutants, emerging contaminants; waste assimilation capacity of streams; dissolved oxygen modeling; ecological balance of streams; industrial pollution; lake pollution and eutrophication; heavy metal contamination; groundwater pollution; marine pollution; water quality problems in Bangladesh; pollution control measures: water quality monitoring and management.

Air pollution: sources and types of pollutants; effects of various pollutants on human health, materials and plants; air pollution meteorology; introduction to air quality models; air pollution monitoring and control measures; global warming, climate change and ozone layer depletion; acid rain.

Noise pollution and control measures.

**CE 437: Basic Environmental Management**
**2.00 credits, 2 hrs/week**

Introduction to environmental management; environmental policies, legislative and institutional framework; environmental implication of sectoral development; environmental quality standards; environmental impact assessment of development projects; strategic environmental assessment; environmental auditing; economics of environmental management; case studies.

**CE 441: Foundation Engineering**
**3.00 credits, 3 hrs/week**

Soil investigation techniques; types of foundations; bearing capacity of shallow and deep foundations; settlement and distortion of foundations; design and construction of footings, rafts and piles; slope stability analyses.

**CE 443: Earth Retaining Structures**
**2.00 credits, 2 hrs/week**

Foundation of structures subjected to lateral loads; rigid and flexible earth retaining structures; methods of construction: dewatering and slurry-wall construction, braced excavation, sheet piles, cofferdams, caissons.

**CE 445: Elementary Soil Dynamics**
**2.00 credits, 2 hrs/week**

Elementary vibrations; dynamic properties of soil; seismic response of soils: site effects, site amplification, liquefaction problems, remedial measures and earthquake hazards.

**CE 447: Soil-water Interaction**
**2.00 credits, 2 hrs/week**

Introduction to soil-water interaction problems: permeability, capillarity and soil suction; slopes subjected to water current, wave action etc; theories of filters and revetment design; geotechnical design of landfills.

**CE 451: Transportation Engineering II: Pavement Design and Railway Engineering**
**4.00 credits, 4 hrs/week**

Pavement materials: bituminous binders, cement, aggregates, embankment material, soil stabilization; mix design methods; low cost roads; flexible and rigid pavement: pavement components and functions, pavement design and construction, road maintenance; railway engineering: general requirements, rolling stock and tracks, stations and yards, points and crossings, signaling, maintenance operations.

**CE 452: Transportation Engineering Sessional I: Highway Materials and Traffic Engineering Design**
**1.50 credits, 3 hrs/week**

Testing and quality control of highway materials; bituminous mix design; roadway traffic and capacity analysis; computer models and application packages.

**CE 453: Transportation Engineering III: Traffic Engineering Design and Management**
**2.00 credits, 2 hrs/week**

Advanced concepts of traffic management, management strategies; analysis of traffic flow characteristics; traffic control devises; intersection control and design; grade separation and interchanges; computer application in traffic system analysis; introduction to micro simulation and ITS; NMT issues and road safety.

**CE 455: Transportation Engineering IV: Pavement Management, Drainage and Airport**
**2.00 credits, 2 hrs/week**

Pavement management systems; evaluation and strengthening of pavements; drainage: highway drainage and drainage structures; airports: importance, advantages and trends in air transportation, planning and design of airports, aircraft characteristics related to airport design, types and elements of airport planning studies, airport configuration, geometric design of the landing area, terminal area, heliports, design of airport pavements, lighting, marking and signing, airport drainage.

**CE 457: Transportation Engineering V: Urban Transportation Planning and Management**
**2.00 credit, 2 hrs/week**

The urban transport problems and trends; road network planning; characteristics and operation of different transit and paratransit modes, planning transit network; estimating system costs and benefits, pricing and financing, evaluation, transit users' attitude, policies and strategies for transit development in metropolitan cities; freight traffic planning and management; selected transport case studies, congestion management; safety management; environmental issues and sustainable transport.

### 16.2 Courses Offered by the Department of Water Resources Engineering

**WRE 211: Fluid Mechanics**
**3.00 credit, 3 hrs/week**

Fluid properties; fluid statics; kinematics of fluid flows; fluid flow concepts and basic equations- continuity equation, Bernoulli's equation, energy equation, momentum equation and forces in fluid flow; steady incompressible flow in pressure conduits, laminar and turbulent flow, general equation for fluid friction; empirical equations for pipe flow; minor losses in pipe flow; pipe flow problems-pipes in series and parallel, branching pipes, pipe networks.

**WRE 212: Fluid Mechanics Sessional**
**1.5 Credit, 3 hrs/week**

Centre of pressure; proof of Bernoulli's theorem; flow through venturimeter; flow through orifice; coefficient of velocity by coordinate method; flow through mouthpiece; flow over v-notch; flow over sharp- crested weir; fluid friction in pipe.

**WRE 311: Open Channel Flow**
**4.00 Credit, 4 hrs/week**

Open channel flow and its classification; velocity and pressure distributions; energy equation, specific energy and transition problems; critical flow and control; principles of flow measurement and devices; concept of uniform flow, Chezy and Manning equations, estimation of resistance coefficients and computation of uniform flow; momentum equation and specific momentum; hydraulic jump theory and analysis of gradually varied flow; computation of flow profiles; design of channels.

**WRE 312: Open Channel Flow Sessional**
**1.5 Credit, 3 hrs/week**

Broad-crested weir; sluice gate; venturi flume; parshall flume; cutthroat flume; hydraulic jump; velocity distribution profile; Manning's roughness coefficient; specific force and specific energy.

**WRE 451: Hydrology, Irrigation and Flood Management**
**3.00 Credit, 3 hrs/week**

Hydrologic cycle; hydrologic measurement: precipitation, evaporation and stream flow; hydrographs; plant-soil-water relationship; consumptive use and estimation of irrigation water requirements; methods of irrigation; quality of irrigation water; problems of irrigated land; flood and its management.

**WRE 405: Flood Mitigation and Management**
**2.00 Credit, 2 hrs/week**

Flood and its causes; methods of flood management: structural and non structural measures such as reservoirs, levees and flood walls, channel improvement, interior drainage, floodways, land management, flood proofing, flood zoning, flood hazard mapping, flood forecasting and warning.

Economic aspects of flood management: flood risk and vulnerability analysis, direct and indirect losses of flood, flood damage assessment, flood damage in urban and rural areas.

**WRE 407: Groundwater Engineering**
**2.00 Credit, 2 hrs/week**

Groundwater in hydrologic cycle and its occurrence. Physical properties and principles of groundwater movement. Groundwater and well hydraulics. Groundwater resource evaluation. Groundwater levels and environmental influences. Water mining and land subsidence. Groundwater pollution and contaminant transport. Recharge of groundwater. Saline water intrusion in aquifers. Groundwater management

**WRE 409: River Engineering**
**2.00 Credit, 2 hrs/week**

Behavior of alluvial rivers; river channel pattern and fluvial processes; aggradation and degradation, local scours, river training and bank protection works; navigation and dredging sediment movement in river channels, bed form and flow regimes.

**WRE 411: Hydraulic Structures**
**2.00 Credit, 2 hrs/week**

Principles of design hydraulic structures, types of hydraulic structures; design of dams, barrages, weirs, spillways, energy dissipators and spillway gates; cross drainage works.

**WRE 413: Coastal Engineering**
**2.00 Credit, 2 hrs/week**

Coast and coastal features; tides and currents; tidal flow measurement; waves and storm surges; docks and harbors; forces of waves and tides in the design of coastal and harbor structures; coastal sedimentation processes; deltas and estuaries; shore protection works; dredging and dredgers.

**16.3 Courses Offered by the Department of Electrical and Electronic Engineering**
**EEE 165: Basic Electrical Technology**
**3.00 Credit, 3 hrs/week**

Electrical units and standards; electrical network and circuit solution: series, parallel, node and mesh analysis; instantaneous current, voltage and power, effective current and voltage, average power; sinusoidal single phase RLC circuits: phasor algebra, balanced three phase circuits; electrical wiring for residential and commercial loads; introduction to transformers and induction motors.

**16.4 Courses Offered by the Department of Physics**
**Phy 101: Physical Optics, Waves and Oscillation, Heat and Thermodynamics**
**3.00 Credit, 3 hrs/week**

**Physical Optics**: theories of light; Young's double slit experiment, displacement of fringes and its uses, Fresnel bi-prism, interference at wedge shaped films, Newton's rings, interferometers; diffraction of light; Fresnel and Fraunhoffer diffraction, diffraction by single slit, diffraction from a circular aperture, resolving power of optical instruments, diffraction at double slit and n-slits-diffraction grating; polarization; production and analysis of polarized light, Brewster's law, Malus law, polarization by double refraction, retardation plates, nicol prism, optical activity, polarimeters, polaroid.

**Waves and Oscillations**: differential equation of a simple harmonic oscillator, total energy and average energy, combination of simple harmonic oscillations, Lissajous figures, spring-mass system, calculation of time period of torsional pendulum, damped oscillation, determination of damping co-efficient; forced oscillation, resonance, two-body oscillations, reduced mass, differential equation of a progressive wave, power and intensity of wave motion, stationary wave, group velocity and phase velocity, architectural acoustics, reverberation and Sabine's formula.

**Heat and Thermodynamics**: principle of temperature measurements: platinum resistance thermometer, thermo-electric thermometer, pyrometer; kinetic theory of gases: Maxwell's distribution of molecular speeds, mean free path, equipartition of energy, Brownian motion, Vander Waal's equation of state, review of the first law of thermodynamics and its application, reversible and irreversible processes, second law of thermodynamics, Carnot cycle; efficiency of heat engines, Carnots theorem, entropy and disorder, thermodynamic functions, Maxwell relations, Clausius-Clapeyron equation, Gibbs phase rule, third law of thermodynamics.

**Phy 102: Physics Laboratory**
**1.50 Credit, 3 hrs/week**
Determination of line frequency by Lissajous figures using an oscilloscope and a function generator and verification of the calibration of time/div knob at a particular position for different frequencies; determination of frequency of a tuning fork by Melde's apparatus; determination of the spring constant and the effective mass of a loaded spring; to draw magnetic induction versus current curve for a circular coil using Biot-Savart law and hence to verify tangent law; determination of the moment of inertia of a fly-wheel about its axis of rotation; determination of rigidity modulus of the material of a wire by static method; determination of the pressure-coefficient of air by constant volume air thermometer; determination of the thermal conductivity of a bad conductor by lee's method; to plot the thermo- electromotive force vs temperature (calibration) curve for a given thermocouple (e5); determination of the melting point of a solid using the calibration curve obtained in experiment-e5; determination of the mechanical equivalent of heat by electrical method; determination of the focal length of (i) a convex lens by displacement method and (ii) a concave lens by an auxiliary lens method; determination of the radius of curvature of a plano-convex lens by Newton's ring method; determination of specific rotation of sugar solution by a polarimeter; to verify Malus' law of polarization; determination of the threshold frequency for the material of a photocathode and hence find the value of the Planck's constant; determination of lattice constant by x-ray.

**Phy 151: Structure of Matter, Electricity and Magnetism and Modern Physics**
**3.00 Credit, 3 hrs/week**

**Structure of Matter** : crystalline and non-crystalline solids, single crystal and polycrystal solids, unit cell, crystal systems, co-ordinations number, crystal planes and directions, NaCl and CsCl structure, packing factor, miller indices, relation between interplanar spacing and Miller indices, Bragg's law, methods of determination of interplanar spacing from diffraction patterns; defects in solids: point defects, line defects, bonds in solids, interatomic distances, calculation of cohesive and bonding energy; introduction to band theory: distinction between metal, semiconductor and insulator.

**Electricity and Magnetism**: coulomb's law, electric field (E), gauss's law and its application, electric potential (V), capacitors and capacitance, capacitors with dielectric, dielectric and atomic view, charging and discharging of a capacitor, Ohm's law, Kirchoff's law; magnetic field: magnetic induction, magnetic force on a current carrying conductor, torque on a current carrying loop, hall effect, faradays law of electromagnetic induction, Lenz's law, self-induction, mutual induction; magnetic properties of matter; hysteresis curve; electromagnetic oscillation: l-c oscillations and its analogy to simple harmonic motion.

**Modern Physics**: Michelson-Morley's experiment, Galilean transformation, special theory of relativity and its consequences; quantum theory of radiation; photo-electric effect, Compton effect, wave particle duality, interpretation of Bohr's postulates, radioactive disintegration, properties of nucleus, nuclear reactions, fission, fusion, chain reaction, nuclear reactor.

**16.5 Courses Offered by the Department of Chemistry**
**Chem 103: Chemistry I**
**3.00 Credit, 3 hrs/week**

Atomic structure and quantum theory: Bohr's theory, Heisenberg's uncertainty principle, Schrödinger's wave equation, electronic configurations and properties of atoms;
Electronic configurations and properties of molecules: chemical bond, valence bond theory molecular orbital theory, shape of molecules, bond length, bond energy;
Chemistry of halogen, alkali metals, alkaline earth metals, non-metals and heavy metals;
Modern concepts of acids and bases;
Different types of solutions; properties of dilute solution; Thermo- chemistry; Electrochemistry: voltaic cells, electrolytic cells; Colloids and colloidal solution; Chemical and ionic equilibria; Chemistry of water; Chemistry of water pollution; Chemistry of cements, silicates and limes.

**Chem 105: Chemistry II**
**3.00 Credit Hours, 3 hrs/week**

Reaction Kinetics: Rate of Chemical Reactions; Order and Molecularity of Reactions, Different Types of Rate Expressions, Methods of Determining Rate and Order, Effect of Temperature on Reaction Rate and Energy of Activation.

Chemical Corrosion: Introduction to Chemical Corrosion, Corrosion of Metals and Alloys in Dry and Wet Environments, Mechanism of Corrosion, Atmospheric and Soil Corrosion and Their Preventive Measures.

Chemistry of Environmental Pollution: Environment and Its Characteristics, Chemistry of Metal and Non-Metal Pollutants, Analytical Techniques used in Determination of Pollutants, Concepts of DO, BOD, COD and Threshold Odor Number, Chemistry Involved in Water Treatment Plants, Quality of Industrial Waste Water.

Polymers: Chemistry of Polymerization, Different Types of Polymers and Their Properties, Polymer Degradation, Elastomers and Composite Materials.

Paints and Varnishes: Introduction to Paints and Varnishes,

Pretreatment of the Surface, Metallic and Non-Metallic and Organic Protective Coating and Their Uses.

**Chem 114: Inorganic Quantitative Analysis**
**1.5 Credit, 3 hrs/week**

Volumetric Analysis: Acidimetry-Alkalimetry; Titrations involving redox reactions, Determination of Cu, Fe and Ca volumetrically; Determination of Ca and Mg in water.

**16.6 Courses Offered by the Department of Mathematics**
**Math 137: Differential and Integral Calculus, Matrices**
**3.00 Credit, 3 hrs/week**

**Differential Calculus**: Limit, Continuity and differentiability; Successive differentiation and Leibnitz's theorem; Expansion of functions; Indeterminate forms; Partial differentiation; Euler's theorem; Tangent and Normal; Maxima and minima of functions of single variables.

**Integral Calculus**: Integration by parts; Standard integrals; Integration by the method of successive reduction; Definite integrals; Beta function; Gamma function; Multiple integrals.

**Matrices**: Definition of different kinds of matrices; Algebra of matrices; Inverse of matrix; Rank and elementary transformation of matrices; Solution of system of linear equations; Eigen values and eigen vectors; Cayley-Hamilton theorem.

**Math 139: Differential Equations and Statistics**
**3.00 Credit, 3 hrs/week**

**Ordinary Differential Equation**: Formation of differential equations; Solution of first order differential equations by various methods; Solution of differential equation of first order but higher degrees; Solution of general linear equations of second and higher orders with constant co-efficient; Solution of Euler's homogeneous linear differential equations.

**Partial Differential Equation**: Introduction, Linear and non-linear first order differential equations; Standard forms; Linear equations of higher order; Equations of the second order with variable co-efficients.

**Statistics**: Measures of central tendency and standard deviation; Moments, Skewness and Kurtosis; Elementary probability theory and discontinuous probability distribution; Continuous probability distributions, e.g. normal and exponential.

**Math 237: Laplace Transform and Vector Analysis**

**3.00 Credit, 3 hrs/week**

**Laplace Transforms**: Definition of Laplace transforms, Sufficient conditions for existence of Laplace transforms; Inverse Laplace transforms; Laplace transforms of derivatives; The unit step function; Periodic function; Some special theorems on Laplace transforms; Partial fraction; Solutions of differential equations by Laplace transforms.

**Vector Analysis**: Scalars and vectors, equality of vectors; Addition and subtraction of vectors; Multiplication of vectors by scalars; Position vector of a point; Scalar and vector product of two vectors and their geometrical interpretation; Triple products and multiple products of vectors; Linear dependence and independence of vectors; Definition of line, surface and volume integral; Gradient, divergence and curl of point functions; Gauss's theorem, Stoke's theorem, Green's theorem and their applications.

**16.7 Courses Offered by the Department of Humanities**
**Hum 185: English**
**2 Credit, 2 hrs/week**

Introduction: current approaches to learning english, communication today.

Phonetics: phonetics and correct english pronunciation.

Syntax: vocabulary, diction and english sentence; sentence variety and style; grammatical problems.

Reading skill: readability, reading strategies, generating ideas through purposive reading, reading of selected stories, comprehension.

Writing skill: principles of effective writing; generating ideas, planning, organization and development of writing; composition, précis.

Written communication: business communication, tenders and quotations, journal articles, report.

Oral communication: dialogue, technical and scientific presentation.

**Hum 217: Engineering Economics**
**2.00 Credit, 2 hrs/week**

Economics and engineering; microeconomics and macroeconomics; theory of demand and supply and their elasticities; demand estimation; price determination; indifference curve technique; theory of production; theory of cost and cost estimation; market structure; national income accounting, depreciation; circular flow of income and expenditure; cost-benefit analysis; payback period, NPV, IRR, inflation; economic feasibility of engineering undertakings.

**Hum 274: Developing English Language Skills**
**1.50 credit, 3 hrs/week**

Reading skill: skimming, scanning, predicting, inferring; analysis and interpretation of texts; comprehension from literary and non-literary texts.

Writing skill: product approach, process approach: brain storming, self-evaluation, peer evaluation, revision/rewriting, teacher's evaluation; techniques of writing: comparison and contrast, problem and solution, cause and effect, classification, illustration; writing paragraph, essay and report.

Listening skill: listening to recorded texts; learning to take useful notes and answering questions.

Speaking skill: dialogue in peer work; participation in discussion and debate; extempore speech; narrating events; story telling; presentation.

**Hum 353: Accounting**
**2.00 Credit, 2 hrs/week**

Financial accounting: objectives and importance of accounting; accounting as an information system; basic accounting principles; accounting equation; recording system; accounting cycle; journal, ledger, trial balance; preparation of financial statements considering adjusting entries; financial statement analysis and interpretation.
Cost accounting: cost concepts and classification; cost-volume-profit analysis; contribution margin approach and its application, break-even analysis, target profit analysis, operating leverage; absorption costing vs variable costing; job order costing; capital budgeting; long run planning and control.

**Hum 355: Sociology**
**2.00 credit, 2 hrs/week**

Nature, scope and perspectives of sociology; stages of social research and research methods; culture and civilization; socialization and personality development; globalization; media and individual; social organization and social problem; social stratification; industrial revolution, capitalism and socialism; work and economic life; environment and human activities; climate change and global risk; population and human society; urbanization and city development; social change and technology.

**Hum 375: Government**
**2.00 Credit, 2 hrs/week**

Basic concepts of government and politics: forms of government; organs of government- legislature, executive, judiciary; functions of government; democracy; socialism; welfare state; bureaucracy; good governance; e-government.

Government and politics of Bangladesh: major administrative reforms;
major amendments to the constitution- non-party caretaker government; local government; public policies; non-government organizations (NGOs); managing development project- planning, implementation, monitoring and evaluation; constitutional bodies- election commission, comptroller and auditor general, public service commission; foreign policy of Bangladesh.

Regional and international organizations: SAARC, ASIAN, UNO.

**16.8 Courses Offered by the Shops**
**Shop 132: Workshop Sessional**
**1.50 Credit, 3 hrs/week Carpentry shop (3/2 hrs/week)**
Wood working tools; wood working machine: band saw, scroll saw, circular saw, jointer, thickness planer, disc sander, wood lathe; types of sawing; common cuts in wood works; types of joint; defects of timber: natural defects and artificial defects; seasoning; preservation; substitute of timber; commercial forms of timber; characteristics of good timber; use of fastening; shop practice: practical job, planning and estimating of a given job.

**Machine shop (3/4 hrs/week)**

Kinds of tools; common bench and hand tools; marking and layout tools, measuring tools, cutting tools, machine tools, bench work with job; drilling, shaper, lathe and milling machines: introduction, type, size and capacity, uses and applications.

**Welding shop (3/4 hrs/week)**

Methods of metal joints: Riveting, grooving soldering, welding; Types of welding joints and welding practice; Position of arc welding and polarty: Flat, vertical, horizontal, overhead; Electric Arc welding and its machineries; Welding of different types of materials: Low carbon steel, cast iron, brass, copper, stainless steel, aluminium; Types of electrode, fluxes and their composition; Arc welding defects; Test of Arc welding: Visual, destructive and non-destructive tests. Types of gas welding system and gas welding equipment; Gases and types of flame; welding of different types of materials; Gas welding defects; test of gas welding.

**16.9 Courses Offered by the Department of Civil Engineering (For students of other Departments)**
**CE 106: Engineering Drawing**
**1.50 credits, 3 hrs/week. (For EEE Dept.)**

Lettering, numbering and heading; instrument and their use; sectional and isometric views of solid geometrical figures; plan, elevation and section of multistoried buildings; drawings of building services; detailed drawing of lattice towers.

**CE 209: Construction Materials**
**2.00 credits, 2 hrs/week. (For URP Dept.)**

Engineering properties and uses of different construction materials - aggregates, brick, cement, sand, lime, mortars, concrete and steel; wood structures and properties; shrinkage and seasoning; treatment and durability; mechanical properties of wood products; fiber reinforced polymer (FRP) composites and its application to civil engineering; basic properties of FRP composites and available FRP composite products; ferrocement: advantages and uses; corrosion of steel in RC structures and its prevention.

**CE 221: Mechanics of Solids I**
**3.00 credits, 3 hrs/week. (For WRE Dept.) Prereq. WRE 101**

Concepts of stress and strain, generalized Hooke's law; deformations due to tension, compression and temperature change; frame statics: reactions, axial force, shear force and bending moments; axial force, shear force and bending moment diagrams of beams using method of section and summation approach; elastic analysis of circular shafts in torsion, solid noncircular and thin walled tubular members subjected to torsion, flexural and shear stresses in beams; shear center; closely coiled helical springs.

**CE 222: Structural Mechanics and Materials Sessional**
**1.50 credits, 3 hrs/week. (For WRE Dept.)**

Tension, direct shear and impact tests of mild steel specimen; slender column test; static bending test; hardness test of metals; helical spring test; determination of shear centre; study of structural models: truss, beam frame.

**CE 223: Mechanics of Solids II**
**3.00 credits, 3 hrs/week. (For WRE Dept.) Prereq. CE 221**

Symmetric and unsymmetrical bending of beams; stresses due to axial load and bending; stress transformation, Mohr's circle of stresses; beam deflection by direct integration and moment area method; elastic buckling of columns; elastic strain energy; cable theorem and cable supported structures, thin walled pressure vessels.

**CE 265: Structure I: Mechanics**
**2.00 credits, 2 hrs/week. (For Arch Dept.)**

Force; equilibrium; free body diagrams; resultants and components; coplanar concurrent forces; moments and parallel coplanar forces; centroids; moment of inertia of areas; fundamental concepts of stress and strain; mechanical properties of materials.

**CE 267: Structure II: Basic Mechanics of Solids**
**2.00 credits, 2 hrs/week. (For Arch Dept.)**

Stresses and strains in members subjected to tension, compression, shear and temperature changes; shear force and bending moment diagrams for statically determinate beams and frames; flexural and shearing stresses in beams by area-moment method.

**CE 271: Building Services I: Plumbing**
**2.00 credits, 2 hrs/week. (For Arch Dept.)**

Introduction to plumbing, water requirements, water sources; water supply and distribution in buildings; sewage and sewer system, building sewer and drainage system, sewage disposal; plumbing of multistoried buildings; rural sanitation programs in Bangladesh.

**CE 290: Details of Construction**
**1.50 credits, 3 hrs/week. (For WRE Dept.)**

Types of building, components of a building, design loads, framed structure and load bearing wall structure; foundations: shallow foundation and deep foundation, site exploration, bearing capacity of soil, standard penetration test; brick masonry: types of brick, bonds in brickwork, supervision of brickwork, brick laying tools, defects and strength on brick masonry, typical structures in brickwork, load bearing and non-load bearing walls, cavity walls, partition walls; lintels and arches: different types of lintels and arches, loading on lintels, construction of arches; stairs: different types of stairs; floors: ground floors and upper floors; roofs and roof coverings; shoring; underpinning; scaffolding and formwork; plastering, pointing, painting; distempering and white washing; cement concrete construction; sound insulation: acoustics; thermal insulation; house plumbing: water supply and wastewater drainage.

**CE 291: Engineering Materials**
**3.00 credits, 3 hrs/week. (For WRE Dept.)**

Properties and uses of aggregates, brick, cement; sand, lime, mortars; concrete; concrete mix design; wood structures and properties; shrinkage and seasoning; treatment and durability; mechanical properties; wood products; advanced fiber reinforced polymer (FRP) composites and its application to civil engineering; reinforcement types, basic property of FRP composites and available FRP composite products; definition of stress and strain; plane stress and strain condition; identification of strain components of elastic, elasto-plastic and elasto-visco-plastic materials; time dependent strain response of these materials due to different types of loadings; mathematical and simple rheological modeling for prediction of creep behavior; ferrocement: advantages and uses; corrosion and prevention of steel in RC structures, offshore structures and ground applications.

**CE 292: Materials Sessional**
**1.50 credits, 3 hrs/week. (For WRE Dept.)**

General discussion on preparation and properties of concrete, test for specific gravity, unit weight, voids and bulking of aggregates; moisture content and absorption of coarse and fine aggregates; normal consistency, initial setting time, soundness and fineness test of cement; direct tensile and compressive strengths of cement mortar; gradation of coarse and fine aggregates; design and testing of a concrete mix, sampling and testing of bricks for absorption, unit weight, efflorescence and compressive strength.

**CE 321: Structural Analysis and Design I**
**4.00 credits, 4 hrs/week. (For WRE Dept.) Prereq. CE 223**

Stability and determinacy of structures; analysis of statically determinate frames, trusses and arches; influence lines; moving loads on beams, frames and trusses; wind and earthquake loads, code provisions; approximate analysis of statically indeterminate structures: mill bents, braced trusses; portal method, cantilever method and vertical load analysis of multi storied building frames; building drift, deflection of beams, trusses and frames by virtual work method; approximate analysis of suspension bridges.

**CE 322: Structural Analysis and Design Sessional**
**1.50 credits, 3 hrs/week. (For WRE Dept.)**

Analysis and design of low rise moment frame building for gravity and wind loads; design of members, connections and columns bases; roof truss.

**CE 323: Design of Concrete Structures I**
**3.00 credits, 3 hrs/week. (For WRE Dept.)**

Fundamental behavior of reinforced concrete and loads on structure; introduction to strength design and alternate design methods; flexural design of beams (singly reinforced, doubly reinforced, t-beam) using strength design method; shear, diagonal tension and torsion of beams; bond and anchorage of reinforcement and its detailing; design of one way slabs; design of two-way edge supported slabs: using strip and alternate methods.

**CE 324: Concrete Structures Design Sessional I**
**1.50 credits, 3 hrs/week. (For WRE Dept.)**

Design and detailing of a low-rise masonry building; design and detailing of a slab bridge; design and detailing of a balanced cantilever bridge.

**CE 325: Design of Concrete Structures II**
**3.00 credits, 3 hrs/week. (For WRE Dept.) Prereq. CE 323**

Design of column supported slabs; introduction to floor systems; structural forms; design of columns under uniaxial and biaxial loading, introduction to slender column; structural design of footings, pile caps; seismic detailing; shear wall subjected to axial load and flexure; introduction to prestressed concrete; analysis and preliminary design of prestressed beam.

**CE 361: Elements of Solid Mechanics 3 credits, 3 hrs/week. (For URP Dept.)**

Force, resultants and components, moments and parallel coplanar forces, centroids, moment of inertia; fundamental concepts of stress and strain; mechanical properties of materials: stress and strain in members subjected to tensile, compressive and shear forces; bending moment and shear force diagrams for statically determinate structures.

**CE 363: Elements of Civil Engineering Structures 3 credits, 3 hrs/week. (For URP Dept.)**

Structural forms and systems for buildings, bridges, communication and transmission structures, flyovers and intersections, road embankments, irrigation, flood control and drainage structures; loads on buildings and structures; uses of steel, concrete and other materials in buildings and structures; types of foundations and their applications; concept of bearing capacity and settlement; evaluation of approximate costs.

**CE 365: Structure III: Reinforced Concrete Design**
**2.00 credits, 2 hrs/week. (For Arch Dept.)**

Fundamentals of reinforced concrete design; concept of WSD and USD methods; analysis and design of reinforced beams by USD; design of slabs, one-way and two-ways; reinforced concrete columns and buckling; introduction to shear walls, earthquake resistant structural systems.

**CE 371: Environmental Engineering**
**4.00 credits, 4 hrs/week (For WRE Dept.)**

Introduction to environmental engineering; water supply: water requirement, water sources, water quality; treatment and distribution systems, design concepts of water treatment plants; wastewater engineering: wastewater characteristics, treatment and disposal, on site sanitation systems; solid waste management. Introduction to environmental pollution; water, air, soil and noise pollution; effects of pollution.

Introduction to environmental management: environmental policy, legislation and environmental quality standards; introduction to environmental impact assessment.

**CE 372: Environmental Engineering Sessional**
**1.5 credits, 3 hrs/week. (For WRE Dept.)**

Sample collection, preservation and storage; physical, chemical and bacteriological tests of water and wastewater; alum coagulation and break point chlorination, preliminary design of water supply and sewerage system.

**CE 381: Principles of Soil Mechanics**
**4.00 credits, 4 hrs/week. (For WRE Dept.)**

Introduction to geotechnical engineering; formation, type and identification of soils; soil composition; soil structure and fabric; index properties of soils; engineering classification of soils; soil compaction; principles of total and effective stresses; permeability and seepage; stress-strain-strength characteristics of soils; compressibility and settlement behavior of soils; lateral earth pressure; stress distribution.

**CE 382: Geotechnical Engineering Laboratory**
**1.50 credits, 3 hrs/week. (For WRE Dept.)**

Field identification tests of soils; grain size analysis by sieve and hydrometer; specific gravity test; Atterberg limits test; permeability tests; unconfined compression test; compaction test; relative density test; direct shear tests; consolidation tests; test of geotextiles.

**CE 391: Transportation Engineering**
**4.00 credits, 4 hrs/week. (For WRE Dept.)**

Introduction to transportation engineering; elements and modes of transportation system; considerations in the planning, financing and development of transportation system; traffic safety issues; highways: highway types, geometric design of highways; traffic characteristics, traffic studies and traffic control devices; highway materials; design, construction and maintenance of low cost pavements, rigid pavements and bituminous pavements; railways: introduction, characteristics, alignment, permanent way, stations and yards, points and crossings; airports: introduction, airport site selection, airport configurations, geometric design of landing area; introduction to waterways and terminals.

**CE 392: Transportation Engineering Sessional**
**1.5 credits, 3 hrs/week. (For WRE Dept.)**

Tests on bituminous materials; tests on sub grade and base materials; roadway capacity studies; problems on the design of roadway geometry and pavements, application of analytical, simulation and statistical packages.

**CE 424: Concrete Structures Design Sessional II**
**1.50 credits, 3 hrs/week. (For WRE Dept.)**

Analysis and design of low rise RC moment frame buildings for wind and low seismic application; multistoried RC buildings with shear wall and mat foundation for wind and high seismic application; reinforcement design and detailing at joints.

**CE 425: Analysis of Indeterminate Structures**
**3.00 credits, 3 hrs/week. (For WRE Dept.) Prereq. 321**

Stiffness properties of beam elements; Moment distribution and flexibility/consistent deformation approaches in solving statically indeterminate structures e.g. beams, frames and trusses; matrix stiffness method in analyzing statically indeterminate beams, plane frames, grids and trusses subject to loads, temperature changes, support settlements etc.; computer application oriented direct stiffness method; influence lines of statically indeterminate structures.

**CE 467: Structure IV: Elements of Building Structure**
**2.00 credits, 2 hrs/week. (For Arch Dept.)**

Approximate analysis of multistoried buildings for gravity and lateral loads; simple analysis of truss sections; analysis and preliminary design of steel beams and columns; introduction to pre-stressed concrete; introduction to various structural forms and system; types of foundations; concept of bearing capacity and settlement.

**CE 471: Basic Environmental Engineering 3 credits, 3 hrs/week. (For URP Dept.)**
Introduction to environmental engineering; human and environment interaction.

Water Supply: objectives and basic elements of water supply system; water requirements; population prediction and water demand assessment; fire demand; planning of water supply systems - sources, abstraction, transmission, treatment and distribution.

Sanitation: urban and rural sanitation; low-cost sanitation technologies; elements of a conventional waterborne sewerage system-collection, transportation, treatment, and disposal; planning of sanitation systems.
Solid waste management: sources and classification; on-site storage and handling; collection, transportation, and disposal; sanitary land filling method; waste recycling and reuse. Environmental pollution - air, water and soil, noise pollution.

**CE 481: Foundation Engineering**
**3.00 credit, 3 hrs/week. (For WRE Dept.)**

Soil investigation techniques; types of foundations; bearing capacity of shallow and deep foundations; settlement and distortion of foundations; design and construction of footings, rafts and piles; slope stability analyses.

**CE 500: Preliminary Structural Design Sessional**
**1.50 credits, 3 hrs/week. (For Arch Dept.)**

Preliminary analysis of multistoried building for gravity and lateral loads incorporating basic seismic resistant structural elements; preliminary proportioning of the structural elements of the building based on structural concepts developed in theory courses; laboratory testing; compression test of concrete cylinders, tension test of mild steel specimen, slender column test.

## 17. Mapping of POs with course outcomes (COs) of all offered courses

| Level and Term | Courses | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level -1 Term-1 | CE 101 | ✓ | ✓ | | | | | | | | | | |
| | CE 100 | ✓ | | | | | | | | | ✓ | | |
| Level -1 Term-2 | CE 103 | ✓ | ✓ | | | | | | | | | | |
| | CE 102 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | ✓ |
| | CE 104 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | |
| Level -2 Term-1 | CE 201 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 203 | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | |
| | CE 211 | ✓ | ✓ | | | | | | | | | | |
| | CE 200 | ✓ | | | ✓ | ✓ | | | | | | | |
| | CE 202 | ✓ | ✓ | | | ✓ | | | | ✓ | | | |
| | CE 204 | ✓ | ✓ | | | ✓ | | | | | | | |
| | CE 210 | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | ✓ |
| Level -2 Term-2 | CE 205 | ✓ | ✓ | | ✓ | | | | | | | | |
| | CE 213 | ✓ | ✓ | | | | | | | | | | |
| | CE 207 | ✓ | ✓ | | | | | | | | | | |
| | CE 206 | ✓ | ✓ | | | ✓ | | | | | | | |
| | CE 208 | ✓ | | | | | | | ✓ | | | | |
| | CE 212 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | ✓ |
| Level -3 Term-1 | CE 301 | | | | | | ✓ | | | | ✓ | ✓ | |
| | CE 311 | ✓ | ✓ | | | | | | | | | | |
| | CE 315 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 331 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 341 | ✓ | ✓ | | | | | | | | | | |
| | CE 302 | | | | | | | | | ✓ | ✓ | | |
| | CE 332 | | ✓ | | ✓ | ✓ | | | | ✓ | | | |
| | CE 342 | ✓ | | | ✓ | | | | | | | | |
| Level -3 Term-2 | CE 317 | ✓ | ✓ | ✓ | | | | | | | ✓ | | |
| | CE 300 | | | | | | ✓ | | ✓ | | ✓ | | ✓ |
| | CE 319 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 333 | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | | | |
| | CE 351 | ✓ | | ✓ | | | ✓ | | | | | | |
| | CE 316 | ✓ | ✓ | ✓ | | | | | | | | | ✓ |
| | CE 320 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| Level -4 | CE 401 | | | ✓ | | | | ✓ | | | | ✓ | |
| | CE 411 | ✓ | ✓ | | | | | | | | | | |

| Level and Term | Courses | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Term-1 | CE 441 | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | CE 451 | ✓ | ✓ | ✓ | | | ✓ | | | | | | |
| | CE 452 | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | CE 400 | | ✓ | ✓ | ✓ | | | | ✓ | | | | ✓ |
| | CE 404 | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | CE 410 | ✓ | ✓ | ✓ | | ✓ | | | | | | | |
| Level -4 Term-2 | CE 403 | | | | | | ✓ | ✓ | | | ✓ | | |
| | CE 405 | | | | | | ✓ | | | ✓ | ✓ | ✓ | ✓ |
| | CE 404 | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | CE 400 | | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | | ✓ |
| | CE 413 | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | CE 415 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 419 | ✓ | ✓ | ✓ | | ✓ | | | | | | | |
| | CE 421 | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | | |
| | CE 433 | ✓ | ✓ | ✓ | | | ✓ | | | | | | |
| | CE 435 | ✓ | ✓ | | | | ✓ | ✓ | | | | | |
| | CE 437 | ✓ | | ✓ | | | ✓ | ✓ | | | | | |
| | CE 443 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 445 | ✓ | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| | CE 447 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 455 | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | | | |
| | CE 457 | ✓ | ✓ | ✓ | | | ✓ | | ✓ | | | | |

# PART C: Detailed Description of Courses with outcome mapping

*(Changes in PART C can be made through the approval of the respective BUGS. The changes made in this part cannot be conflicting with the content of PART A, PART B and the UG Ordinance of BUET.)*

## 18. CO-PO Mapping

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level -1 Term -1 | CE 101 | CO1 | ✓ | ✓ | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | | | | | | | | | | |
| | | CO4 | ✓ | ✓ | | | | | | | | | | |
| | CE 100 | CO1 | ✓ | | | | | | | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO2 | ✓ | | | | | | | | | | | |
| | | CO3 | ✓ | | | | | | | | | ✓ | | |
| | | CO4 | ✓ | | | | | | | | | ✓ | | |
| Level-1 Term-2 | CE 103 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | | | | | | | | | | |
| | | CO4 | ✓ | | | | | | | | | | | |
| | CE 102 | CO1 | | ✓ | | | ✓ | | | | ✓ | | | ✓ |
| | | CO2 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | |
| | | CO3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | |
| | | CO4 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| | CE 104 | CO1 | ✓ | ✓ | | ✓ | ✓ | | | | ✓ | ✓ | | |
| | | CO2 | ✓ | | ✓ | | ✓ | | | | ✓ | | | |
| Level-2 Term-1 | CE 201 | CO1 | ✓ | ✓ | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | | | | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | CE 203 | CO1 | ✓ | | | | | ✓ | | | | | | |
| | | CO2 | ✓ | | | ✓ | | | | | | | | |
| | | CO3 | | ✓ | | ✓ | | | | | | | | |
| | | CO4 | | ✓ | ✓ | | | | ✓ | | | | | |
| | | CO5 | ✓ | | ✓ | | | | | | | | | |
| | | CO6 | ✓ | ✓ | | | | | | | | | | |
| | CE 211 | CO1 | ✓ | ✓ | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | | | | | | | | | | |
| | | CO4 | ✓ | ✓ | | | | | | | | | | |

| Level and Term | Courses | COs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CE 200 | CO 1 | | | | ✓ | | | | | | | | |
| | | CO 2 | ✓ | | | ✓ | | | | | | | | |
| | | CO 3 | | | | ✓ | ✓ | | | | | | | |
| | | CO 4 | | | | ✓ | | | | | | | | |
| | | CO 5 | ✓ | | | ✓ | | | | | | | | |
| | CE 202 | CO 1 | ✓ | | | | | | | | ✓ | | | |
| | | CO 2 | ✓ | | | | | | | | ✓ | | | |
| | | CO 3 | ✓ | ✓ | | | ✓ | | | | ✓ | | | |
| | | CO 4 | ✓ | ✓ | | | | | | | ✓ | | | |
| | | CO 5 | ✓ | | | | | | | | ✓ | | | |
| | | CO 6 | ✓ | | | | | | | | ✓ | | | |
| | CE 204 | CO 1 | ✓ | ✓ | | | ✓ | | | | | | | |
| | | CO 2 | | ✓ | | | ✓ | | | | | | | |
| | | CO 3 | ✓ | ✓ | | | ✓ | | | | | | | |
| | | CO 4 | ✓ | ✓ | | | ✓ | | | | | | | |
| | | CO 5 | ✓ | ✓ | | | ✓ | | | | | | | |
| | CE 210 | CO 1 | ✓ | | | | | ✓ | ✓ | ✓ | | | | ✓ |
| | | CO 2 | ✓ | ✓ | ✓ | | | ✓ | | ✓ | | | | ✓ |
| Level -2 Term -2 | CE 205 | CO 1 | ✓ | | | | | | | | | | | |
| | | CO 2 | ✓ | ✓ | | | | | | | | | | |
| | | CO 3 | ✓ | | | ✓ | | | | | | | | |
| | | CO 4 | ✓ | | | | | | | | | | | |
| | CE 213 | CO 1 | ✓ | | | | | | | | | | | |
| | | CO 2 | ✓ | | | | | | | | | | | |
| | | CO 3 | ✓ | | | | | | | | | | | |
| | | CO 4 | ✓ | ✓ | ✓ | | | | | | | | | |
| | | CO 5 | ✓ | | | | | | | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO 6 | ✓ | | | | | | | | | | | |
| | | CO 7 | ✓ | | | | | | | | | | | |
| | CE 207 | CO 1 | ✓ | ✓ | | | | | | | | | | |
| | | CO 2 | ✓ | ✓ | | | | | | | | | | |
| | | CO 3 | ✓ | ✓ | | | | | | | | | | |
| | | CO 4 | ✓ | ✓ | | | | | | | | | | |
| | | CO 5 | ✓ | ✓ | | | | | | | | | | |
| | CE 206 | CO 1 | | | | | ✓ | | | | | | | |
| | | CO 2 | | | | | ✓ | | | | | | | |
| | | CO 3 | ✓ | ✓ | | | ✓ | | | | | | | |
| | CE 208 | CO 1 | ✓ | | | | | | | | | | | |
| | | CO 2 | ✓ | | | | | | | ✓ | | | | |
| | | CO 3 | ✓ | | | | | | | ✓ | | | | |
| | | CO 4 | ✓ | | | | | | | ✓ | | | | |
| | CE 212 | CO 1 | ✓ | | | ✓ | | | | | | | | |
| | | CO 2 | ✓ | | | ✓ | ✓ | | | | | | | |
| | | CO 3 | ✓ | | | | ✓ | | | | | | | |
| | | CO 4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | ✓ |
| Level -3 Term -1 | CE 301 | CO 1 | | | | | | | | | | ✓ | ✓ | |
| | | CO 2 | | | | | | | | | | ✓ | ✓ | |
| | | CO 3 | | | | | | | | | | ✓ | | |
| | | CO 4 | | | | | | | | | | | ✓ | |
| | | CO 5 | | | | | | ✓ | | | | | | |
| | | CO 6 | | | | | | ✓ | | | | | | |
| | CE 311 | CO 1 | ✓ | | | | | | | | | | | |
| | | CO 2 | ✓ | | | | | | | | | | | |
| | | CO 3 | ✓ | ✓ | | | | | | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO4 | ✓ | ✓ | | | | | | | | | | |
| | | CO5 | ✓ | | | | | | | | | | | |
| | | CO6 | ✓ | ✓ | | | | | | | | | | |
| | CE 315 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | ✓ | | | | | | | | | |
| | | CO3 | ✓ | ✓ | ✓ | | | | | | | | | |
| | | CO4 | ✓ | ✓ | ✓ | | | | | | | | | |
| | | CO5 | ✓ | ✓ | ✓ | | | | | | | | | |
| | CE 331 | CO1 | ✓ | | | | | | ✓ | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | ✓ | | | | | | | | | |
| | | CO4 | | ✓ | | | ✓ | | | | | | | |
| | | CO5 | ✓ | ✓ | | | | | | | | | | |
| | CE 341 | CO1 | ✓ | ✓ | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | | | | | | | | | | |
| | | CO4 | ✓ | ✓ | | | | | | | | | | |
| | | CO5 | ✓ | ✓ | | | | | | | | | | |
| | | CO6 | ✓ | ✓ | | | | | | | | | | |
| | | CO7 | ✓ | ✓ | | | | | | | | | | |
| | | CO8 | ✓ | ✓ | | | | | | | | | | |
| | CE 302 | CO1 | | | | | | | | | ✓ | ✓ | | |
| | | CO2 | | | | | | | | | ✓ | ✓ | | |
| | | CO3 | | | | | | | | | ✓ | ✓ | | |
| | | CO4 | | | | | | | | | ✓ | ✓ | | |
| | | CO5 | | | | | | | | | ✓ | | | |
| | | CO6 | | | | | | | | | ✓ | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CE 332** | **CO1** | | | | ✓ | | | | | ✓ | | | |
| | | **CO2** | | | | ✓ | ✓ | | | | ✓ | | | |
| | | **CO3** | | ✓ | | ✓ | | | | | ✓ | | | |
| | **CE 342** | **CO1** | ✓ | | | ✓ | | | | | | | | |
| | | **CO2** | ✓ | | | ✓ | | | | | | | | |
| **Level-3 Term-2** | **CE 300** | **CO1** | | | | | | ✓ | | ✓ | | | | |
| | | **CO2** | | | | | | | | | | | | ✓ |
| | | **CO3** | | | | | | | | | | ✓ | | |
| | **CE 317** | **CO1** | ✓ | | ✓ | | | | | | | | | |
| | | **CO2** | ✓ | ✓ | | | | | | | | | | |
| | | **CO3** | ✓ | ✓ | ✓ | | | | | | | | | |
| | | **CO4** | ✓ | | | | | | | | | ✓ | | |
| | | **CO5** | ✓ | ✓ | ✓ | | | | | | | | | |
| | | **CO6** | ✓ | | | | | | | | | | | |
| | | **CO7** | ✓ | ✓ | ✓ | | | | | | | | | |
| | **CE 319** | **CO1** | ✓ | ✓ | ✓ | | | | | | | | | |
| | | **CO2** | ✓ | ✓ | ✓ | | | | | | | | | |
| | | **CO3** | ✓ | | ✓ | | | | | | | | | |
| | | **CO4** | ✓ | ✓ | ✓ | | | | | | | | | |
| | | **CO5** | ✓ | ✓ | ✓ | | | | | | | | | |
| | **CE 333** | **CO1** | ✓ | ✓ | | | | ✓ | ✓ | | | | | |
| | | **CO2** | | ✓ | ✓ | | | | | | | | | |
| | | **CO3** | ✓ | | | | | ✓ | ✓ | | | | | |
| | | **CO4** | | | ✓ | | | ✓ | ✓ | | | | | |
| | | **CO5** | | ✓ | ✓ | | | | | | | | | |
| | | **CO6** | ✓ | ✓ | | | | | | | | | | |
| | | **CO7** | ✓ | ✓ | | | | | | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO8 | ✓ | | ✓ | | | | | | | | | |
| | CE 351 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | | | | | ✓ | | | | | | |
| | | CO3 | | | ✓ | | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | CE 316 | CO1 | ✓ | ✓ | | | | | | | | | | ✓ |
| | | CO2 | ✓ | ✓ | ✓ | | | | | | | | | ✓ |
| | | CO3 | | | ✓ | | | | | | | | | ✓ |
| | CE 320 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | | ✓ | | | | | | | | | | |
| | | CO3 | | | | | ✓ | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | | | | ✓ | | | | | | | | |
| Level-4 Term-1 | CE 401 | CO1 | | | | | | | | | | | ✓ | |
| | | CO2 | | | | | | | | | | | ✓ | |
| | | CO3 | | | | | | | | | | | ✓ | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | | | | | | | | | | | ✓ | |
| | | CO6 | | | | | | | ✓ | | | | | |
| | CE 411 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | | | | | | | | | | | |
| | | CO3 | | ✓ | | | | | | | | | | |
| | | CO4 | | ✓ | | | | | | | | | | |
| | CE 441 | CO1 | ✓ | | | ✓ | | | | | | | | |
| | | CO2 | | ✓ | ✓ | | | | | | | | | |
| | | CO3 | | ✓ | | | | | | | | | | |
| | | CO4 | ✓ | ✓ | | | | | | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO5 | | | ✓ | | | | | | | | | |
| | CE 451 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | | | | | ✓ | | | | | | |
| | | CO3 | | ✓ | | | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | CE 452 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | ✓ | | | | | | | | |
| | | CO3 | ✓ | | ✓ | | | | | | | | | |
| | CE 400 | CO1 | | ✓ | | | | | | | | | | |
| | | CO2 | | | | | | | | ✓ | | | | ✓ |
| | | CO3 | | | | ✓ | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | | | | ✓ | | | | | | | | ✓ |
| | | CO6 | | | | | | | | ✓ | | | | |
| | | CO7 | | | | | | | | | | ✓ | | |
| | CE 404 | CO1 | | | | | ✓ | | | | | | | |
| | | CO2 | | | | | | | | | ✓ | | | |
| | | CO3 | | | | | | ✓ | ✓ | | | | | |
| | | CO4 | | | | | | | | ✓ | | | | |
| | | CO5 | | | | | | | | | | | | ✓ |
| | | CO6 | | | | | | | | | | | ✓ | |
| | | CO7 | | | | | | | | | | ✓ | | |
| | CE 410 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | ✓ | | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | | ✓ | | | ✓ | | | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level-4 Term-2 | CE 403 | CO1 | | | | | | ✓ | ✓ | | | ✓ | | |
| | | CO2 | | | | | | ✓ | ✓ | | | | | |
| | | CO3 | | ✓ | ✓ | | | ✓ | | | | | | |
| | | CO4 | | | ✓ | | | ✓ | | | | | | |
| | | CO5 | | | | | | ✓ | | | | | | |
| | | CO6 | | ✓ | | | | ✓ | | | | | | |
| | | CO7 | | | ✓ | | | ✓ | | | | | | |
| | CE 404 | CO1 | | | | | ✓ | | | | | | | |
| | | CO2 | | | | | | | | | ✓ | | | |
| | | CO3 | | | | | | ✓ | ✓ | | | | | |
| | | CO4 | | | | | | | | ✓ | | | | |
| | | CO5 | | | | | | | | | | | | ✓ |
| | | CO6 | | | | | | | | | | | ✓ | |
| | | CO7 | | | | | | | | | | ✓ | | |
| | CE 405 | CO1 | | | | | | ✓ | | | | | ✓ | |
| | | CO2 | | | | | | ✓ | | | | | | ✓ |
| | | CO3 | | | | | | | | | ✓ | ✓ | | |
| | | CO4 | | | | | | | | | | | ✓ | |
| | CE 400 | CO1 | | ✓ | | | | | | | | | | |
| | | CO2 | | | | ✓ | | | | ✓ | | | | ✓ |
| | | CO3 | | ✓ | | ✓ | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | | ✓ | | ✓ | | | | | | | | ✓ |
| | | CO6 | | | | | | | | ✓ | | | | ✓ |
| | | CO7 | | | | | | | | | | ✓ | | ✓ |
| | CE 413 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | |
| | CE 415 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | | ✓ | | | | | | | | | | |
| | | CO3 | | ✓ | | | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | ✓ | | | | | | | | | | | |
| | | CO6 | ✓ | | ✓ | | | | | | | | | |
| | CE 419 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | | | | | | | | | | | |
| | | CO3 | | ✓ | | | | | | | | | | |
| | | CO4 | | ✓ | | | | | | | | | | |
| | | CO5 | | ✓ | | | | | | | | | | |
| | | CO6 | | | ✓ | | | | | | | | | |
| | | CO7 | | | | | ✓ | | | | | | | |
| | CE 421 | CO1 | ✓ | | ✓ | | | ✓ | | | | | | |
| | | CO2 | ✓ | | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | | | | | | | | | | |
| | | CO4 | ✓ | | | | ✓ | | | | | | | |
| | | CO5 | ✓ | | | | | | | | | | | |
| | CE 433 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | ✓ | | | | | | | | | | |
| | | CO3 | ✓ | ✓ | ✓ | | | | | | | | | |
| | | CO4 | ✓ | ✓ | ✓ | | | ✓ | | | | | | |
| | | CO5 | ✓ | ✓ | ✓ | | | ✓ | | | | | | |
| | CE 435 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | | ✓ | | | | | | | | | | |
| | | CO3 | | ✓ | | | | ✓ | ✓ | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO4 | | ✓ | | | | | | | | | | |
| | | CO5 | ✓ | | | | | ✓ | ✓ | | | | | |
| | | CO6 | ✓ | | | | | | | | | | | |
| | CE 437 | CO1 | ✓ | | | | | ✓ | ✓ | | | | | |
| | | CO2 | ✓ | | | | | ✓ | ✓ | | | | | |
| | | CO3 | ✓ | | ✓ | | | ✓ | ✓ | | | | | |
| | | CO4 | | | | | | | ✓ | | | | | |
| | | CO5 | ✓ | ✓ | | | | ✓ | ✓ | | | | | |
| | CE 443 | CO1 | ✓ | | ✓ | | | | | | | | | |
| | | CO2 | | ✓ | ✓ | | | | | | | | | |
| | | CO3 | | ✓ | ✓ | | | | | | | | | |
| | | CO4 | | ✓ | ✓ | | | | | | | | | |
| | CE 445 | CO1 | ✓ | | | | | | | | | | | ✓ |
| | | CO2 | ✓ | | | | | | | | | | | ✓ |
| | | CO3 | | ✓ | ✓ | | | | | | | | | ✓ |
| | | CO4 | | ✓ | | ✓ | | | | | | | | ✓ |
| | CE 447 | CO1 | ✓ | ✓ | | | | | | | | | | |
| | | CO2 | | | ✓ | | | | | | | | | |
| | | CO3 | ✓ | ✓ | | | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | ✓ | | ✓ | | | | | | | | | |
| | CE 455 | CO1 | ✓ | | | | | | | | | | | |
| | | CO2 | ✓ | | | | | ✓ | | | | | | |
| | | CO3 | | | ✓ | | | | | | | | | |
| | | CO4 | | | ✓ | | | | | | | | | |
| | | CO5 | | ✓ | | | | | | | | | | |
| | | CO6 | | | ✓ | | | | ✓ | | | | | |

| Level and Term | Courses | COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CE 457 | CO 1 | ✓ | | | | | | | | | | | |
| | | CO 2 | | ✓ | | | | | | | | | | |
| | | CO 3 | | | ✓ | | | | | | | | | |
| | | CO 4 | | ✓ | | | | ✓ | | ✓ | | | | |

## 19. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Course No. | COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CE 100 | CO-1 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CE 101 | CO-1 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CE 102 | CO-1 | | ✓ | | | | ✓ | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |
| CE 103 | CO-1 | ✓ | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CE 104 | CO-1 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | |
| | CO-2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | |
| CE 200 | CO-1 | | | | | | | | ✓ | | | | | | | | | | | | |
| | CO-2 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| | CO-3 | | | | | | ✓ | | ✓ | | | | | | | | | | | | |

| Course No. | COs | K1 | K 2 | K 3 | K 4 | K 5 | K 6 | K 7 | K 8 | P 1 | P 2 | P 3 | P 4 | P 5 | P 6 | P 7 | A 1 | A 2 | A 3 | A 4 | A 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO-4 | | | | | | | | ✓ | | | | | | | | | | | | |
| | CO-5 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CE 201 | CO-1 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| CE 202 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-5 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CE 203 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| | CO-5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-6 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| CE 204 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| | CO-5 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| CE 205 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CE 206 | CO-1 | | | | | | ✓ | | | | | | | | | | | | | | |
| | CO-2 | | | | | | ✓ | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| CE 207 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-5 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CE 208 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | |
| CE 210 | CO-1 | | | √ | | | | | | | | | | | | | | | | | |
| | CO-2 | | | √ | | | | | | | | | | | | | | | | | |
| | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |

| Course No. | COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CE 211** | **CO-2** | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-3** | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-4** | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| **CE 212** | **CO-1** | | | ✓ | | | | | | | | | | | | | | | | | |
| | **CO-2** | | | ✓ | | | | ✓ | | | | | | | | | | | | | |
| | **CO-3** | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-4** | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| **CE 213** | **CO-1** | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| | **CO-2** | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| | **CO-3** | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| | **CO-4** | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-5** | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-6** | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-7** | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-8** | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| **CE 300** | **CO-1** | | | | | | | ✓ | | | | | | | | | | | | | |
| | **CO-2** | | | | | | | | | | | | | | | | | | | | |
| | **CO-3** | | | | | | | | | | | | | | | | | | | | |
| **CE 301** | **CO-1** | | | | √ | | | | | | | | | | | | | | | | |
| | **CO-2** | | | | | √ | | | | | | | | | | | | | | | |
| | **CO-3** | | | | | √ | | | | | | | | | | | | | | | |
| | **CO-4** | | | | | √ | | | | | | | | | | | | | | | |
| | **CO-5** | | | | | | | √ | | | | | | | | | | | | | |
| | **CO-6** | | | | | | | √ | | | | | | | | | | | | | |
| **CE 302** | **CO-1** | | | | | | √ | | | | | | | | | | | | | | |
| | **CO-2** | | | | | √ | | | | | | | | | | | | | | | |
| | **CO-3** | | | | | | √ | | | | | | | | | | | | | | |
| | **CO-4** | | | | | | √ | | | | | | | | | | | | | | |
| | **CO-5** | | | | | | √ | | | | | | | | | | | | | | |
| **CE 311** | **CO-1** | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-2** | | | | ✓ | | | | | | | | | | | | | | | | |
| | **CO-3** | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-4** | | | | ✓ | | | | | | | | | | | | | | | | |
| | **CO-5** | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-6** | | | | ✓ | | | | | | | | | | | | | | | | |
| **CE 315** | **CO-1** | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | **CO-2** | ✓ | | | ✓ | ✓ | | | | | | | | | | | | | | | |
| | **CO-3** | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | **CO-4** | ✓ | | | ✓ | ✓ | | | | | | | | | | | | | | | |
| | **CO-5** | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | |
| | **CO-1** | | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | | ✓ | | |

| Course No. | COs | K1 | K 2 | K 3 | K 4 | K 5 | K 6 | K 7 | K 8 | P 1 | P 2 | P 3 | P 4 | P 5 | P 6 | P 7 | A 1 | A 2 | A 3 | A 4 | A 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CE 316 | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | | | | | | ✓ | ✓ | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | ✓ | ✓ | | | | ✓ |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | ✓ | | |
| CE 317 | CO-1 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-4 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-7 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CE 319 | CO-1 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-2 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-4 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-5 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-6 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-7 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-8 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-9 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-10 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CE 320 | CO-1 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| | CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| CE 331 | CO-1 | ✓ | | | | | | ✓ | | | | | | | | | ✓ | | | | |
| | CO-2 | | | | ✓ | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| | CO-3 | | | | ✓ | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| | CO-4 | | ✓ | | | ✓ | | | | | | | | | | | ✓ | | | | |
| | CO-5 | ✓ | | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| CE 332 | CO-1 | | | | | | | | ✓ | | | | | | | | | | | | |
| | CO-2 | | | | | | ✓ | | ✓ | | | | | | | | | | | | |
| | CO-3 | | | ✓ | | | | | ✓ | | | | | | | | | | | | |
| CE 333 | CO-1 | ✓ | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| | CO-2 | | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | | |
| | CO-3 | | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| | CO-4 | | | | | ✓ | | ✓ | | | | | | | | | | | | | |
| | CO-5 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-6 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| | CO-7 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| | CO-8 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-1 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |

| Course No. | COs | K1 | K 2 | K 3 | K 4 | K 5 | K 6 | K 7 | K 8 | P 1 | P 2 | P 3 | P 4 | P 5 | P 6 | P 7 | A 1 | A 2 | A 3 | A 4 | A 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CE 341 | CO-2 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-5 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-7 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-8 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CE 342 | CO-1 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| | CO-2 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| | CO-3 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CE 351 | CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-2 | | | | | | | ✓ | | | | | | | | | | | | | |
| | CO-3 | | | | | ✓ | | | | | | | | | | | | | | | |
| | CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| CE 400 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | | | | | | | | ✓ | | ✓ |
| | CO-2 | | | ✓ | ✓ | | | | | ✓ | | | | | | | | | ✓ | | ✓ |
| | CO-3 | | | | | | | ✓ | | | | | | | | | | | ✓ | | |
| | CO-4 | | | | | | | | ✓ | ✓ | | ✓ | | | | | ✓ | | | | ✓ |
| | CO-5 | | | | | ✓ | | | | | | ✓ | ✓ | | | | ✓ | | | | |
| | CO-6 | | | | | | | | ✓ | ✓ | | | | | | | | | ✓ | | |
| | CO-7 | | | | | | | ✓ | | | | | | | | | ✓ | | | | |
| CE 401 | CO-1 | | | | √ | | | | | | | | | | | | | | | | |
| | CO-2 | | | | √ | | | | | | | | | | | | | | | | |
| | CO-3 | | | | √ | | | | | | | | | | | | | | | | |
| | CO-4 | | | | | √ | | | | | | | | | | | | | | | |
| | CO-5 | | | | | | √ | | | | | | | | | | | | | | |
| | CO-6 | | | | | | | √ | | | | | | | | | | | | | |
| CE 403 | CO-1 | | | | | | | √ | | | | | | | | | | | | | |
| | CO-2 | | | | | | | √ | | | | | | | | | | | | | |
| | CO-3 | | | | | | | √ | | | | | | | | | | | | | |
| | CO-4 | | | | | | | √ | | | | | | | | | | | | | |
| | CO-5 | | | | | | | √ | | | | | | | | | | | | | |
| CE 404 | CO-1 | | | | | | ✓ | | | ✓ | ✓ | | | | | ✓ | ✓ | | ✓ | | |
| | CO-2 | | | | | | | ✓ | | | | | | | | | | ✓ | | | |
| | CO-3 | | | | | | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ | | |
| | CO-4 | | | | | | | ✓ | | | | | ✓ | | | | | | | | |
| | CO-5 | | | | | | | | | ✓ | | | | | ✓ | | | | | ✓ | |
| | CO-6 | | | | | | | | | ✓ | ✓ | | ✓ | | | | | ✓ | | ✓ | |
| | CO-7 | | | | | | | | | | | | | | | | | | | | |
| CE 405 | CO-1 | √ | | | | | | | | | | | | | | | | | | | |
| | CO-2 | √ | | | | | | | | | | | | | | | | | | | |

| Course No. | COs | K1 | K 2 | K 3 | K 4 | K 5 | K 6 | K 7 | K 8 | P 1 | P 2 | P 3 | P 4 | P 5 | P 6 | P 7 | A 1 | A 2 | A 3 | A 4 | A 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO-3 | ✓ | | | | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | | | | | | | | | | | | | | | | | | | |
| CE 410 | CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |
| | CO-2 | | | | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| | CO-5 | | | | | | ✓ | | | | | | | | | | | | | | |
| CE 411 | CO-1 | ✓ | ✓ | | | | | | | | | | | | | | | | | | |
| | CO-2 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-5 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-6 | | | | ✓ | | | | | | | | | | | | | | | | |
| CE 413 | CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |
| | CO-2 | | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| | CO-3 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | | | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CE 415 | CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | | | | | | | | | | | | | | | | | | |
| | CO-3 | | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | | | | ✓ | | | | | | | | | | | | | | | |
| | CO-5 | | | | ✓ | | | | | | | | | | | | | | | | |
| | CO-6 | ✓ | | | | ✓ | | | | | | | | | | | | | | | |
| CE 419 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | | ✓ | | | | | | | | |
| | CO-3 | | ✓ | ✓ | ✓ | | | | | ✓ | | | ✓ | | | | | | | | |
| | CO-4 | | ✓ | ✓ | | | | | | ✓ | | | ✓ | | | | | | | | |
| | CO-5 | | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | | | | | | | | |
| | CO-6 | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | |
| | CO-7 | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | |
| CE 421 | CO-1 | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| | CO-5 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| CE 433 | CO-1 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-3 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-4 | | | | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| | CO-5 | | | | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| | CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |

| Course No. | COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CE 435 | CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| | CO-4 | ✓ | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-5 | | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| | CO-6 | | | | ✓ | | | | | | | | | | | | | | | | |
| CE 437 | CO-1 | ✓ | | | | | | ✓ | | | | | | | | | | | | √ | |
| | CO-2 | ✓ | | | | | | ✓ | | | | | | | | | | | | √ | |
| | CO-3 | | ✓ | | | | | ✓ | ✓ | | | | | | | | | | | √ | |
| | CO-4 | | | | | | | ✓ | | | | | | | | | | | | √ | |
| | CO-5 | ✓ | ✓ | | | | | ✓ | | | | | | | | | | | | √ | |
| CE 441 | CO-1 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-5 | | | | | ✓ | | | | | | | | | | | | | | | |
| CE 443 | CO-1 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CE 445 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CE 447 | CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-2 | | | | | ✓ | | | | | | | | | | | | | | | |
| | CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| | CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| | CO-5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CE 451 | CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-2 | | | | | | | ✓ | | | | | | | | | | | | | |
| | CO-3 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| CE 452 | CO-1 | | | | | | ✓ | | | | | | | | | | | | | | |
| | CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-3 | | | | | ✓ | | | | | | | | | | | | | | | |
| CE 454 | CO-1 | | ✓ | | | | | | | | | | | | | | | | | | |
| | CO-2 | | | | | ✓ | | | | | | | | | | | | | | | |
| | CO-3 | | | | | | | ✓ | | | | | | | | | | | | | |
| CE 455 | CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| | CO-3 | | | | | ✓ | | | | | | | | | | | | | | | |

| Course No. | COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CO-4** | | | | | ✓ | | | | | | | | | | | | | | | |
| | **CO-5** | | ✓ | | | | | | | | | | | | | | | | | | |
| | **CO-6** | | | | | | | ✓ | | | | | | | | | | | | | |
| **CE 457** | **CO-1** | | | ✓ | | | | | | | | | | | | | | | | | |
| | **CO-2** | | | ✓ | | | | | | | | | | | | | | | | | |
| | **CO-3** | | | | | ✓ | | | | | | | | | | | | | | | |
| | **CO-4** | | | | | | | ✓ | | | | | | | | | | | | | |

## 20. Description of all courses of the program

## 20.1 Description of Course CE 100

**SECTION A: General Information**

**1.** Course Title — **Civil Engineering Drawing**

**2.** Type of Course — Basic Engineering (Compulsory)

**3.** Offered to — Civil Engineering

**4.** Pre-requisite Course(s) — None

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Lines and lettering; plane geometry: drawing of linear and curved geometric figures, e.g., pentagon, hexagon, octagon, ellipse, parabola, hyperbola; solid geometry: concept of isometric view and oblique view, theory of projections; drawing of isometric view of 3d objects such as cube, prism, pyramid, cone, and cylinder; projections of cube, prism, cone, cylinder; developments of cube, pyramid, cone, cylinder; plan, elevations, and sections of one storied and duplex building.**

**6.** Course Objectives

- To introduce basic geometric figures associated with engineering drawing
- To familiarize with different views and projections of any object
- To introduce building drawings with plan and sectional views

**7.** Knowledge required

Preliminary knowledge in geometry

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *comprehend* the basics of engineering drawing | PO(a) | C2 | Lectures, Assignment | Class assessment, Quiz |
| 2 | *interpret* building drawing plan, elevation & section of two storied building | PO(a) | C2 | Lectures, Assignment | Class assessment, Quiz |
| 3 | *perform* the task related to civil engineering drawing | PO(a) | C2 | Lectures, Assignment | Class assessment, Quiz |
| 4 | *apply* concepts of engineering drawing | PO(a) PO(l) | C3 | Lectures, Assignment | Class assessment, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction, lettering & Numbering | Handout, Book | CO1 |
| Lecture 2 | Drawing of Regular Polygons | Handout, Book | CO1 |
| Lecture 3 | Drawing of curved geometric figures and theory of projection | Handout, Book | CO1 |
| Lecture 4 | 1st and 3rd angle projection and drawing of isometric objects | Handout, Book | CO1 |
| Lecture 5 | 45◦ projection method | Handout, Book | CO1 |
| Lecture 6 | Review class of geometric drawing | Handout, Book | CO1 |
| Lecture 7 | MID QUIZ | Handout, Book | CO3<br>CO4 |
| Lecture 8 | Introduction to Building Drawing: Plan, Elevation & Section of one Room Building | Handout, Book | CO1<br>CO2 |
| Lecture 9 | One storied building drawing: Plan, Elevation and Section | Handout, Book | CO1<br>CO2 |
| Lecture 10 | Two storied building drawing: Plan, Elevation and Section | Handout, Book | CO1<br>CO2 |
| Lecture 11 | Zigzag and Inclined section of two storied building | Handout, Book | CO1<br>CO2 |
| Lecture 12 | Review of Building drawing | Handout, Book | CO1<br>CO2 |
| Lecture 13 | FINAL QUIZ | Handout, Book | CO3<br>CO4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment:
    - 6 to 7 Class Assessments will be taken
    - Assessment will be based on either the topic taught on that day or topic taught on the previous day or combination of the two topics.
    - Assignment and/or homework will be provided to ensure the active engagement even outside class hours.
- Quizzes: Two no's quizzes will be administered.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Assignment | 30% |
| Class Assessment | 20% |
| Quiz | 40% |

**13.** Textbook

1. **"Technical Drawing"** by Frederick E. Giesecke, Alva Mitcheel, Henry Cecil Spencer, Ivan Leroy Hill, John Thomas Dygdon
2. Class Lecture Handout

**14.** References

1. **"Engineering Drawing"** by D.N. Ghose.
2. **"Civil Engineering Drawing"** by D.N. Ghose.
3. **"Civil Engineering Drawing"** by Gurcharan Singh and Subhash Chander Sharma.

## 20.2 Description of Course CE 101

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Analytic Mechanics** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Coplanar and non-coplanar force systems; moments; analyses of two- dimensional frames and trusses; friction; flexible chords; centroids of lines, areas, and volumes; moments of inertia of areas and masses; plane motion; principles of work and energy; impulse and momentum; virtual work principle for rigid bodies.**

**6.** Course Objectives

- To introduce different force systems
- To familiarize with two dimensional trusses
- To introduce virtual work principal

**7.** Knowledge required

Preliminary knowledge in force systems

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *comprehend* different force systems on rigid bodies under static equilibrium | PO(a) PO(b) | C2 | Lectures, Book | Class Test, Final Exam |
| 2 | *compute* section properties of structural members | PO(a) PO(b) | C3 | Lectures, Book | Class Test, Final Exam |
| 3 | *comprehend* dynamic equilibrium of rigid bodies | PO(a) PO(b) | C2 | Lectures, Book | Class Test, Final Exam |
| 4 | *apply* energy methods for static and dynamic problems of rigid bodies | PO(a) PO(b) | C3 | Lectures, Book | Class Test, Final Exam |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction of Mechanics | Lecture, Book | CO1 |
| Lecture 2 | Force and free body diagram | Lecture, Book | CO1 |
| Lecture 3 | Introduction to the course | Lecture, Book | CO1 |
| Lecture 4-5 | Concurrent Coplanar Forces and equilibrium | Lecture, Book | CO1<br>CO2 |
| Lecture 6 | Kinematics of rectilinear motion of particles | Lecture, Book | CO3 |
| Lecture 7-8 | Parallel Coplanar Forces and equilibrium | Lecture, Book | CO1<br>CO2 |
| Lecture 9 | Kinematics of curvilinear motion of particles | Lecture, Book | CO3 |
| Lecture 10-11 | Nonparallel nonconcurrent coplanar Forces and equilibrium | Lecture, Book | CO1<br>CO2 |
| Lecture 12 | Kinetics of friction problems; Class test on kinematics. | Lecture, Book | CO3 |
| Lecture 13 | 2D Frame Analysis | Lecture, Book | CO1<br>CO2 |
| Lecture 14 | Kinetics of suspended bodies | Lecture, Book | CO3 |
| Lecture 15-16 | 2D Truss Analysis | Lecture, Book | CO1<br>CO2 |
| Lecture 17 | Kinetics of Simple Harmonic Motion | Lecture, Book | CO3 |
| Lecture 18-19 | Friction | Lecture, Book | CO1 |
| Lecture 20 | Work and energy principle of a body in linear motion | Lecture, Book | CO4 |
| Lecture 21 | **Class Test 1** | Lecture, Book | CO1 |
| Lecture 22-23 | Non-coplanar Forces and equilibrium | Lecture, Book | CO1<br>CO2 |
| Lecture 24 | Work and energy principle of a rotating body | Lecture, Book | CO4 |
| Lecture 25-26 | Flexible chords | Lecture, Book | CO1<br>CO2 |
| Lecture 27 | Application of work and energy principle of a body in combined motion | Lecture, Book | CO4 |
| Lecture 28-30 | Centroids of lines, areas, and volumes | Lecture, Book | CO1 |
| Lecture 31 | Impulse and momentum; Class test on work and energy principle. | Lecture, Book | CO4 |
| Lecture 32-34 | Moments of inertia of areas | Lecture, Book | CO1 |
| Lecture 35 | Angular impulse and angular momentum | Lecture, Book | CO4 |
| Lecture 36 | **Class Test 2** | Lecture, Book | CO2 |
| Lecture 37-39 | Moments of inertia of masses | Lecture, Book | CO1 |
| Lecture 40 | Application of impulse and momentum principle of a body in combined motion | Lecture, Book | CO4 |
| Lecture 41-42 | Principle of virtual work | Lecture, Book | CO4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Test | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **"Analytical Mechanics"** Ferries and Chambers

**14.** References

1. **"Engineering Mechanics: Dynamics"** by Meriam & Kraige, 7th Edition
2. **"A Textbook of Engineering Mechanics"** by Khurmi, 20th Edition
3. **"Vector Mechanics for Engineers"** by Beer et al., 9th Edition
4. **"Engineering Mechanics"** by Shames, 4th Edition
5. **"Engineering Mechanics"** by Hibbeler, 12th Edition

## 20.3 Description of Course CE 102

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Computer Aided Drafting** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

**Introduction to computer usage; introduction to CAD packages and computer aided drafting: drawing editing and dimensioning of simple objects; plan, elevations, and sections of multi-storied buildings; reinforcement details of beams, slabs, stairs etc; plan and section of septic tank; detailed drawings of roof trusses; plans, elevations and sections of culverts, bridges, and other hydraulic structures; drawings of building services.**

**6.** Course Objectives

- To introduce CAD packages and computer aided drafting
- To draw different views and projections of any object using computer aided drafting
- To introduce different building components and civil engineering structures

**7.** Knowledge required

Preliminary knowledge in civil drawing

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *explain* the basics of AutoCAD drawing | PO(b)<br>PO(e)<br>PO(i)<br>PO(l) | C2 | Lectures, Assignment | Class assessment, Quiz |
| 2 | *interpret* views and dimensions of basic engineering objects with the help of draw, modify etc. tools. | PO(a)<br>PO(b)<br>PO(c)<br>PO(d)<br>PO(e)<br>PO(i) | C2 | Lectures, Assignment | Class assessment, Quiz |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 3 | *produce* plans & elevation views and structural elements of buildings including the reinforcement details | PO(a)<br>PO(b)<br>PO(c)<br>PO(d)<br>PO(e)<br>PO(i) | C3 | Lectures, Assignment | Class assessment, Quiz |
| 4 | *analyse* a given plan of building or structural element, *decide* on appropriate command tools and *develop* section views in AutoCAD. | PO(a)<br>PO(b)<br>PO(c)<br>PO(d)<br>PO(e) | C4, C5, C6 | Lectures, Assignment | Class assessment, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | ✓ | | | | ✓ | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | 1. AutoCAD Screen<br>2. X-Y Co-Ordinate System<br>3. Angular Measurement<br>4. Drawing Units & Limits<br>5. AutoCAD Basics (Toolbars, Menus, Keystrokes)<br>6. Drawing Commands (Introduction to Drawing & Modifying Commands – Line & Erase)<br>7. Entering points in AutoCAD (Absolute & Relative)<br>8. Viewing of Object (Zooming & Panning)<br>9. Object Selection<br>10. Drawing Aids (Ortho, Grid, Snap, Polar Tracking, The Function Keys)<br>11. Object Snaps<br>12. Accurate Input | Lecture, Book | CO1 |

| Class No. | Topics | References | Correspondin g CO(s) |
|---|---|---|---|
| Lecture 2 | (a) Drawing Commands (Construction Line, Ray, Polyline, Rectangle, Polygon, Donut, Revcloud, Circle, Arcs, Spline, Ellipse, Ellipse Arc, Region, Wipeout, Points & Point Styles, Multiline & Multiline Styles etc)<br>(b) Basic Drawing skills | Lecture, Book | CO1 |
| Lecture 3 | (a) Modifying Commands (Copy, Mirror, Offset, Array, Move, Rotate, Scale, Stretch, Lengthen, Trim, Extend, Break, Break at Point, Chamfer, Fillet, Explode etc.)<br>(b) Modifying Objects | Lecture, Book | CO1<br>CO2 |
| Lecture 4 | (a) Concept of Layers<br>(b) Creating a New Layer, Setting Colour, Line Type & Line With<br>(c) Controlling Layer Status<br>(d) Drawing in Layers<br>(e) Changing Object Properties<br>(f) Match Properties<br>(g) Renaming a Layer, deleting a Layer, Purging Layers & Line types etc. | Lecture, Book | CO1<br>CO2 |
| Lecture 5 | (a) Text writing, Editing, & Creating Text Styles<br>(b) Hatching & edits an existing Hatch<br>(c) Make Blocks, Write Blocks & Insert Blocks<br>(d) Using Design Centre & Tool Palettes<br>(e) Using Express Tools<br>(f) Printing (Setting up Printers, Page Setup, Printing in Model Space)<br>(g) Printing (Make a Layout & Printing with Layout)<br>(h) Class Assessment | Lecture, Book | CO1<br>CO2 |
| Lecture 6 | Reinforcement details of beams, columns, slabs, stairs, foundation; plan and section of septic tank | Lecture, Book | CO3<br>CO4 |
| Lecture 7 | Final Quiz (Written) | Lecture, Book | CO1<br>CO2 |
| Lecture 8 | Plot longitudinal and transverse sections of beams in AutoCAD | Lecture, Book | CO3<br>CO4 |
| Lecture 9 | Plot column sections and foundation with reinforcement details in AutoCAD<br>Class Assessment | Lecture, Book | CO3<br>CO4 |
| Lecture 10 | Plot stair with reinforcement details in AutoCAD<br>Class Assessment | Lecture, Book | CO3<br>CO4 |
| Lecture 11 | Plot plan view and sections of slab with reinforcement details in AutoCAD | Lecture, Book | CO3<br>CO4 |
| Lecture 12 | Plot plan and section of septic tank. | Lecture, Book | CO3<br>CO4 |
| Lecture 13 | Plot plans, elevations and sections of culverts, bridges, and other hydraulic structures; Detailed drawings of roof trusses | Lecture, Book | CO3<br>CO4 |
| Lecture 14 | AutoCAD quiz (computer based) | Lecture, Book | CO3<br>CO4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.

- Continuous Assessment:
  - 6 to 7 Class Assessments will be taken
  - Assessment will be based on either the topic taught on that day or topic taught on the previous day or combination of the two topics.
  - Assignment and/or homework will be provided to ensure the active engagement even outside class hours.
- Quizzes: Two no's quizzes will be administered.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Assignment | 20% |
| Class Assessment | 30% |
| Quizzes | 40% |

**13.** Textbook

1. **"Mastering AutoCAD and AutoCAD LT"** by George Omura, Brain C. Benton
2. **"AutoCAD & AutoCAD LT"** by Ellen Finkelstein

**14.** References

6. **"AutoCAD"** by Prof. Sham Tickoo

## 20.4 Description of Course CE 103

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Surveying** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

**Reconnaissance survey; linear measurements; traverse survey; triangulation, leveling and contouring; calculation of areas and volumes; problems on heights and distances; curves and curve ranging, transition curve, vertical curves; tacheometry: introduction, principles and problems on tacheometry; astronomical surveying: definition, instruments, astronomical corrections, systems of time; photogrammetry: introduction of terrestrial photography, aerial photography, reading of photo mosaic, scale; project surveying; errors in surveying; remote sensing; introduction to geographic information system (GIS) and global positioning system (GPS).**

**6.** Course Objectives

- To introduce different survey techniques
- To familiarize with modern survey tools and techniques
- To introduce astronomical surveying

**7.** Knowledge required

Preliminary knowledge in geometry

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *explain* principles and techniques of basic and advanced surveying | PO(a) | C2 | Lectures, Book | Class Test, Final Exam |
| 2 | *estimate* various parameters required for plotting topographic and contour maps for various projects | PO(a)<br>PO(b) | C2 | Lectures, Book | Class Test, Final Exam |
| 3 | *determine* necessary design components of horizontal and vertical curves in roadways | PO(a)<br>PO(b) | C4 | Lectures, Book | Class Test, Final Exam |
| 4 | *calculate* land areas and volumes for cut and fills for a field project | PO(a) | C4 | Lectures, Book | Class Test, Final Exam |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | ✓ | | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1-3 | Introductory class: course contents and lecture plan. | Lecture, Book | CO1 |
| Lecture 4 | Introduction on Photogrammetry Surveying | Lecture, Book | CO1 |
| Lecture 5 | Curves and curve ranging- alignment design; Types of curves; Definition and elements of simple curve. | Lecture, Book | CO3 |
| Lecture 6 | Reconnaissance survey | Lecture, Book | CO1 |
| Lecture 7 | Elevation of a point and its determination | Lecture, Book | CO2 |
| Lecture 8 | Terrestrial Photographs | Lecture, Book | CO1 |
| Lecture 9 | Curve setting- Linear and angular methods of curve setting. | Lecture, Book | CO3 |
| Lecture 10 | Linear measurements | Lecture, Book | CO1 |
| Lecture 11 | Surveying operations | Lecture, Book | CO1 |
| Lecture 12 | Transition Curve – Characteristics of transition curve; | Lecture, Book | CO1 |
| Lecture 13 | Chain surveying | Lecture, Book | CO3 |
| Lecture 14 | Problems of height and distance | Lecture, Book | CO1 |
| Lecture 15 | Lecture on Aerial Photographs | Lecture, Book | CO2 |
| Lecture 16 | Super-elevation and design considerations; | Lecture, Book | CO1 |

| | | | |
|---|---|---|---|
| Lecture 17 | Class Test 1 | Lecture, Book | CO3 |
| Lecture 18 | Computation of area - Trapezoidal rule | Lecture, Book | CO1 |
| Lecture 19 | Different parameters of Aerial Photographs | Lecture, Book | CO4 |
| Lecture 20 | Exercise problems on horizontal curves. | Lecture, Book | CO1 |
| Lecture 21 | Compass and Theodolite | Lecture, Book | CO3 |
| Lecture 22 | Computation of area - Simpson's rule | Lecture, Book | CO1 |
| Lecture 23 | Examples of some mathematical problems related to Photogrammetry Surveying | Lecture, Book | CO4 |
| Lecture 24 | Vertical curves- Vertical curve fundamentals; Design of vertical curves. | Lecture, Book | CO1 |
| Lecture 25 | Traverse survey | Lecture, Book | CO3 |
| Lecture 26 | Computation of volume | Lecture, Book | CO1 |
| Lecture 28 | Mathematical problems related to Photogrammetry Surveying | Lecture, Book | CO4 |
| Lecture 29 | Exercise problems on vertical curves. | Lecture, Book | CO1 |
| Lecture 30 | Traverse survey | Lecture, Book | CO3 |
| Lecture 31 | Computation of volume | Lecture, Book | CO1 |
| Lecture 32 | Class Test 2 | Lecture, Book | CO4 |
| Lecture 33 | Class Test 3 | Lecture, Book | CO1 |
| Lecture 34 | Class Test 4 | Lecture, Book | CO3 |
| Lecture 35 | Curvature correction of volume | Lecture, Book | CO1 |
| Lecture 36 | Instruments of levelling | Lecture, Book | CO4 |
| Lecture 37 | Tacheometry- Introduction; principle of stadia method; Distance and elevation formula; | Lecture, Book | CO2 |
| Lecture 38 | Leveling | Lecture, Book | CO1 |
| Lecture 39 | Astronomical surveying | Lecture, Book | CO2 |
| Lecture 40 | Leveling | Lecture, Book | CO1 |
| Lecture 41 | Exercise problems on tacheometry; | Lecture, Book | CO2 |
| Lecture 42 | Leveling | Lecture, Book | CO1 |
| Lecture 43 | Mathematical problems related to leveling Surveying | Lecture, Book | CO2 |
| Lecture 44 | Astronomical surveying - problems on transit | Lecture, Book | CO2 |
| Lecture 45 | Mathematical problems related to leveling Surveying | Lecture, Book | CO1 |
| Lecture 46 | Contouring | Lecture, Book | CO2 |
| Lecture 47 | Astronomical surveying - spherical trigonometry | Lecture, Book | CO2 |
| Lecture 48 | Project surveying. | Lecture, Book | CO1 |
| Lecture 49-50 | Errors in surveying | Lecture, Book | CO1<br>CO2<br>CO3 |
| Lecture 51 | Astronomical surveying - problems on time | Lecture, Book | CO1 |
| Lecture 52 | Modern survey tools | Lecture, Book | CO1 |
| Lecture 53-56 | Review | Lecture, Book | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. The best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Test | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **“Surveying”** Volume: 2 & 3 by B.C. Punmia
2. **“A textbook of surveying”** by M. A. Aziz and M. Shahjahan

**14.** References

Lecture materials provided by course teacher

## 20.5 Description of Course CE 104

**SECTION A: General Information**

**1.** Course Title — **Practical Surveying**

**2.** Type of Course — Basic Engineering (Compulsory)

**3.** Offered to — Civil Engineering

**4.** Pre-requisite Course(s) — None

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

**Linear and angular measurement techniques; traverse surveying; leveling and contouring; curve setting; tacheometry; project surveying; modern surveying equipment and their applications.**

**6.** Course Objectives

- To introduce Linear and angular measurement techniques; traverse surveying; leveling and contouring; tacheometry; and traverse surveying
- To demonstrate project surveying
- To familiarize with modern surveying equipment and their applications

**7.** Knowledge required

Preliminary knowledge in surveying

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *apply* basic survey and mapping techniques for civil infrastructure | PO(a)<br>PO(b)<br>PO(d)<br>PO(e)<br>PO(i)<br>PO(j) | C3 | Lectures, Assignment | Practical Demonstration, Viva, Quiz |
| 2 | *execute* field setting out of road curves, house plan, contour plan and route project using conventional and modern survey tools | PO(a)<br>PO(c)<br>PO(e)<br>PO(i) | C2 | Lectures, Assignment | Practical Demonstration, Viva, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | |
| CO-2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Registration<br>Issue of Instruments<br>Instruction & Handling of all Instruments | Lecture, Book | CO1 |
| Lecture 2 | Quiz on Instruments<br>Chain & Plane Table Survey | Lecture, Book | CO1 |
| Lecture 3 | Leveling and Closed Traverse | Lecture, Book | CO1 |
| Lecture 4 | Curve Setting | Lecture, Book | CO1<br>CO2 |
| Lecture 5 | Boarding on Bus at 7:15 am.<br>Bus starts for the survey spot at 7:30 am sharp<br>Instruction & Assignment (Contouring & Project Surveying: Reconnaissance) | Lecture, Book | CO1<br>CO2 |
| Lecture 6 | Leveling and Closed Traverse Boarding on Bus at 7:15 am<br>Bus starts for the survey spot at 7:30 am sharp<br>Instruction & Assignment (Project Surveying: Traversing, Plane Tabling and Leveling) | Lecture, Book | CO1<br>CO2 |
| Lecture 7 | Stadia Survey, Height, and distance problem | Lecture, Book | CO1 |
| Lecture 8 | Introduction of EDM, Total Station & GPS<br>House Setting | Lecture, Book | CO2 |
| Lecture 9 | Final Quiz & Practical Oral Examination<br>Return of Instruments as per the program to be circulated later. | Lecture, Book | CO1<br>CO2 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment:
    - 6 to 7 Practical Demonstration will be taken
    - The practical Demonstration will be based on either the topic taught on that day
    - Assignments and/or homework will be provided to ensure active engagement even outside class hours.
- Viva: One viva will be administered.
- Quizzes: Two no's quizzes will be administered.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Assignment | 20% |
| Practical Demonstration | 20% |
| Viva | 20% |
| Quiz | 30% |

**13.** Textbook

1. **“Surveying”** by Dr.B.C.Punmia

**14.** References

1. **“Surveying”** by M Shahjahan and M.A.Aziz
2. **“Surveying for Engineers”** by J.Uren and W.F.Price

## 20.6 Description of Course CE 200

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Details of Construction** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Types of building, components of a building, design loads, framed structure and load bearing wall structure; foundations: shallow foundation and deep foundation, site exploration, bearing capacity of soil, standard penetration test; brick masonry: types of brick, bonds in brickwork, supervision of brickwork, brick laying tools, defects and strength on brick masonry, typical structures in brickwork, load bearing and non-load bearing walls, cavity walls, partition walls; lintels and arches: different types of lintels and arches, loading on lintels, construction of arches; stairs: different types of stairs, floors: ground floors and upper floors; roofs and roof coverings; shoring; underpinning; scaffolding and formwork; plastering, pointing, painting; distempering and white washing; cement concrete construction; sound insulation: acoustics; thermal insulation; house plumbing: water supply and wastewater drainage.**

**6.** Course Objectives

- To introduce different civil engineering structures
- To familiarize different construction techniques
- To introduce different construction materials

**7.** Knowledge required

Preliminary knowledge in civil engineering structures

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *compare* different types of building, components of a building, design loads and service loads, framed structure and load bearing wall structure. | PO(d) | C2 | Lectures, Assignment | Class assessment, Presentation, Quiz |
| 2 | *discover* different foundation types, site exploration techniques, methods related to determining bearing capacity of soil. | PO(a)<br>PO(d) | C2 | Lectures, Assignment | Class assessment, Presentation, Quiz |
| 3 | *present* the advantages and disadvantages of brick masonry as well as the associated building components. | PO(d)<br>PO(e) | C3 | Lectures, Assignment | Class assessment, Presentation, Quiz |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 4 | *describe* the importance of shoring, underpinning, scaffolding, and formwork in civil engineering construction. | PO(d) | C2 | Lectures, Assignment | Class assessment, Presentation, Quiz |
| 5 | *explain* the necessity of plastering, pointing, painting, distempering, white washing, sound insulation, thermal insulation, water supply and wastewater drainage in construction and operation of civil engineering structures. | PO(a)<br>PO(d) | C2 | Lectures, Assignment | Class assessment, Presentation, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | | ✓ | | | | | | | | | | | | |
| CO-2 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CO-3 | | | | | | ✓ | | ✓ | | | | | | | | | | | | |
| CO-4 | | | | | | | | ✓ | | | | | | | | | | | | |
| CO-5 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1-2 | Types of Building and its Components; Load types | Lecture, Book | CO1 |
| Lecture 3 | Framed structure, Load bearing wall structure | Lecture, Book | CO1 |
| Lecture 4-5 | Site Exploration and Different types of foundation | Lecture, Book | CO2 |
| Lecture 6 | Features of concrete | Lecture, Book | CO1 |
| Lecture 7 | Beam, column & slab construction | Lecture, Book | CO1 |
| Lecture 8 | Brick masonry structures | Lecture, Book | CO3 |
| Lecture 9-10 | Building services: Plumbing & water supply | Lecture, Book | CO5 |
| Lecture 11 | Lintels and arches: different types of lintels and arches | Lecture, Book | CO1 |
| Lecture 12 | Elements of Roof and stair | Lecture, Book | CO1 |
| Lecture 13 | Shoring, underpinning, scaffolding, and formwork | Lecture, Book | CO4 |
| Lecture 14 | Plastering, pointing, painting; distempering and white washing | Lecture, Book | CO5 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment:
  - 6 to 7 Class Assessments will be taken
  - Assessment will be based on either the topic taught on that day or topic taught on the previous day or combination of the two topics.
  - Assignment and/or homework will be provided to ensure the active engagement even outside class hours.
- Quizzes: Two no's quizzes will be administered.
- Presentation: One group presentation will be administered.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Assignment and Class Assessment | 30% |
| Presentation | 10% |
| Quiz | 50% |

**13.** Textbook

1. **"Building Construction"** by Sushil Kumar.

**14.** References

1. **"Building Construction"** by Rangawala.
2. Lecture Notes on CE 200.

## 20.7 Description of Course CE 201

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Engineering Materials** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Properties and uses of aggregates, brick, cement; sand, lime, mortars; concrete; concrete mix design; wood structures and properties; shrinkage and seasoning; treatment and durability; mechanical properties; wood products; advanced fiber reinforced polymer (FRP) composites and its application to civil engineering; reinforcement types, basic property of FRP composites and available FRP composite products; definition of stress and strain; plane stress and strain condition; identification of strain components of elastic, elasto-plastic and elasto-visco-plastic materials; time dependent strain response of these materials due to different types of loadings; mathematical and simple rheological modeling for prediction of creep behavior; ferrocement: advantages and uses; corrosion and prevention of steel in RC structures, offshore structures and ground applications.**

**6.** Course Objectives

- To introduce different engineering materials and their uses.

**7.** Knowledge required

Preliminary knowledge in materials.

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *comprehend* the behavior, characteristics, and significance of various construction materials. | PO(a)<br>PO(b) | C2 | Lectures, Book | Class Test, Final Exam |
| 2 | *apply* the concept of stress-strain behavior to understand the strain-response of different materials. | PO(a)<br>PO(b) | C3 | Lectures, Book | Class Test, Final Exam |
| 3 | *discuss* the corrosion behavior and its control measures for steel and RCC structures | PO(a) | C2 | Lectures, Book | Class Test, Final Exam |
| 4 | *design* concrete mix considering various parameters using standard guidelines and practices. | PO(c) | C6 | Lectures, Book | Class Test, Final Exam |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1-4 | Stress-Strain Behavior | Lecture, Book | CO2 |
| Lecture 5 | Introduction to Engineering Materials | Lecture, Book | CO1 |
| Lecture 6 | Introduction | Lecture, Book | CO1 |
| Lecture 7 | Metals and Alloys | Lecture, Book | CO1 |
| Lecture 8 | Properties and uses of cement | Lecture, Book | CO4 |
| Lecture 9 | Properties and classification of sand | Lecture, Book | CO1 |
| Lecture 10 | Class Test-1 | Lecture, Book | CO1<br>CO2 |
| Lecture 11 | Properties and uses of cement | Lecture, Book | CO4 |
| Lecture 12 | Field and Laboratory tests of sand including sieve analysis and water absorption | Lecture, Book | CO1 |
| Lecture 13 | Ferrocement | Lecture, Book | CO2 |
| Lecture 14 | Properties and uses of cement | Lecture, Book | CO4 |
| Lecture 15 | Properties and classification of Stones | Lecture, Book | CO1 |
| Lecture 16-17 | Corrosion and It’s Prevention | Lecture, Book | CO2 |
| Lecture 18 | Class Test-1 | Lecture, Book | CO1<br>CO4 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 19 | Classification and characteristics of Aggregates, blending of aggregates | Lecture, Book | CO1 |
| Lecture 20 | Class Test- 2 | Lecture, Book | CO2 |
| Lecture 21 | Properties and uses of brick | Lecture, Book | CO1 |
| Lecture 22 | Class Test 1 | Lecture, Book | CO1 |
| Lecture 23 | Plastic | Lecture, Book | CO1 |
| Lecture 24 | Properties and uses of brick | Lecture, Book | CO1 |
| Lecture 25 | Introduction to concrete and Its Components, Stress & Strength | Lecture, Book | CO4 |
| Lecture 26 | Rubber | Lecture, Book | CO1 |
| Lecture 27 | Properties and uses of lime, mortars & other finishing materials | Lecture, Book | CO4 |
| Lecture 28 | Properties of Concrete; problems associated with fresh and hardened concrete | Lecture, Book | CO4 |
| Lecture 29 | Glass | Lecture, Book | CO1 |
| Lecture 30 | Properties and uses of lime, mortars & other finishing materials | Lecture, Book | CO4 |
| Lecture 31 | Introduction to Concrete Mix Design, Old methods of mix design | Lecture, Book | CO4 |
| Lecture 32 | Insulating Materials | Lecture, Book | CO1 |
| Lecture 33 | Properties and uses of lime, mortars & other finishing materials | Lecture, Book | CO4 |
| Lecture 34 | British Method of Mix Design | Lecture, Book | CO4 |
| Lecture 35 | ACI Method of Mix Design | Lecture, Book | CO4 |
| Lecture 36 | Properties and uses of lime, mortars & other finishing materials | Lecture, Book | CO4 |
| Lecture 37 | Example Problems of Mix Design | Lecture, Book | CO4 |
| Lecture 38-39 | Wood structures and properties | Lecture, Book | CO1 |
| Lecture 40 | Properties and uses of lime, mortars & other finishing materials | Lecture, Book | CO4 |
| Lecture 41 | Properties and classification of Mortars | Lecture, Book | CO4 |
| Lecture 42 | Review | Lecture, Book | CO4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Test | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **"Concrete Technology"** by A. M. Neville and J.J. Brooks.

**14.** References

1. **"Building Materials"** by G. Singh.
2. **"Engineering materials"** by M A Aziz
3. Lecture materials provided by course teacher

## 20.8 Description of Course CE 202

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Materials Sessional** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**General discussion on preparation and properties of concrete, test for specific gravity, unit weight, voids and bulking of aggregates; moisture content and absorption of coarse and fine aggregates; normal consistency, initial setting time, soundness and fineness test of cement; direct tensile and compressive strengths of cement mortar; gradation of coarse and fine aggregates; design and testing of a concrete mix, sampling and testing of bricks for absorption, unit weight, efflorescence and compressive strength.**

**6.** Course Objectives

- To introduce variables relevant to physical properties of various construction materials
- To identify appropriate instrumentation and technique to measure physical and mechanical properties of construction materials

**7.** Knowledge required

- Preliminary knowledge in materials

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *identify* dependent and independent variables relevant to physical properties of various construction materials including cement, brick, aggregates and concrete. | PO(a), PO(i) | C4 | Lectures, Class participation | Class Test, Lab Report, Quiz |
| 2 | *identify* appropriate instrumentation and technique to measure physical and mechanical properties of construction materials | PO(a), PO(i) | C4 | Lectures, Class participation | Class Test, Lab Report, Quiz |
| 3 | *record* and *analyze* experimental data in a meaningful way | PO(a), PO(b), PO(d), PO(i) | C4 | Lectures, Class participation | Class Test, Lab Report, Quiz |
| 4 | *apply* critical thinking and judgments about the results of experiment | PO(a), PO(b), PO(i) | C3 | Lectures, Class participation | Class Test, Lab Report, Quiz |
| 5 | *recognize* the importance of various properties of cement, brick and aggregates as it relates to construction | PO(a), PO(i) | C4 | Lectures, Class participation | Class Test, Lab Report, Quiz |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 6 | *evaluate* effect of various parameters on concrete quality and strength | PO(a), PO(i) | C5 | Lectures, Class participation | Class Test, Lab Report, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Engineering Materials Lab Tests | Materials Sessional Laboratory Manual | CO1 |
| Lecture 2 | Determination of Normal Consistency of Cement Using Vicat's Apparatus | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 3 | Determination of Initial Setting Time of Cement Using Vicat's Apparatus | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 4 | Determination of Compressive Strength of Hydraulic Cement Mortars | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 5 | Determination of Soundness of Cement by Expansion of Cement Mortar Bars | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| | | | CO5<br>CO6 |
| Lecture 6 | Mid Term Viva and Quiz | | |
| Lecture 7 | Determination of Fineness of Cement by Air Permeability Apparatus | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 8 | Determination of Compressive Strength of Concrete Using Cylindrical and Cube Specimens | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 9 | Testing and Sampling of Bricks for Compressive Strength, Efflorescence and Absorption | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 10 | Sieve Analysis of Fine and Coarse Aggregate | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 11 | Determination of Specific Gravity and Absorption of Fine and Coarse Aggregate | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 12 | Determination of Unit Weight & Voids in Fine and Coarse Aggregate | Materials Sessional Laboratory Manual | CO2<br>CO3<br>CO4<br>CO5<br>CO6 |
| Lecture 13 | Review Class | | |
| Lecture 14 | Final Viva and Quiz | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least eight class tests will be administered. Best five of them will be counted towards grading.
- Mid and Final Quiz: Two comprehensive quiz examinations will be held during mid-term and at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests/ Assessments | 20% |
| Lab Report | 15% |
| Mid Quiz | 20% |
| Final Quiz | 20% |
| Mid Viva | 7.5% |
| Final Viva | 7.5% |

**13.** Textbook

"*CE 202 Materials Sessional Laboratory Manual"* by Snigdha Afsana, Assistant Professor, Department of Civil Engineering, BUET.

**14.** References

- 1. Engineering Materials by M A Aziz;
- 2. Properties of Concrete by A.M Neville;
- 3. Building Materials by Gurcharan Sing

## 20.9 Description of Course CE 203

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Engineering Geology and Geomorphology** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Minerals; identification of minerals, common rock forming minerals; physical properties of minerals; mineraloids rocks; types of rocks, cycle of rock change; earthquake and seismic map of Bangladesh. Structural geology; faults; types of faults; fold and fold type; domes; basins; erosional process; quantitative analysis of erosional land forms. Channel development; channel widening; valley shape; stream terraces; alluvial flood plains; deltas and alluvial fans; channel morphology; channel patterns and the river basin; geology and geomorphology of Bangladesh.**

**6.** Course Objectives

- To describe the importance of geology and geomorphology in civil engineering projects
- To explain various technical terms used in geological and geomorphological investigation reports
- To analyse geological information for assessment of geological hazards

**7.** Knowledge required

- Preliminary knowledge in basic geology.

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* |
|---|---|---|
| 1 | *describe* the importance of geology and geomorphology in civil engineering projects | PO(a), PO(f) |
| 2 | *explain* various technical terms used in geological and geomorphological investigation reports | PO(a), PO(d) |
| 3 | *apply* basic concepts of geological formation for better understanding of geological information/data | PO(b), PO(d) |

| CO No. | CO Statement | Corresponding PO(s)* |
|---|---|---|
| 4 | *analyse* geological information for assessment of geological hazards | PO(b), PO(c), PO(g) |
| 5 | *discuss* basic concepts of geomorphological formation for better understanding of interaction with the civil engineering infrastructure | PO(a), PO(c) |
| 6 | *apply* geomorphological processes for assessment of infrastructure-based project impacts in the long run | PO(a), PO(b) |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Week 1 | Introductory class: course contents and lecture plan | Handnotes | CO1 |
| Week 2-3.5 | Minerals | Handnotes | CO2<br>CO3<br>CO4 |
| Week 3.5-4.5 | Geological Time and Principles of Formation | Handnotes | CO2<br>CO3<br>CO4 |
| Week 4.5-6 | Rocks, Rock cycle | Handnotes | CO2<br>CO3<br>CO4 |
| Week 7-7.5 | Class Test 1 | | |
| Week 7.5-9.5 | Erosional Process and erosional landforms | Handnotes | CO2<br>CO3<br>CO4 |
| Week 9.5-11 | Plate Tectonics, Earthquake Mechanism, Faults and Folds, Seismic Hazard Map of Bangladesh | Handnotes | CO2<br>CO3<br>CO4 |
| Week 12-12.5 | Class Test 2 | | |
| Lecture 12.5-13 | Domes and Basins, Mountain formation, Sea-bed features, Volcanoes, Lakes | Handnotes | CO2<br>CO3<br>CO4 |
| Week 14 | Review | | |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Week 1 | Introduction | Handnotes | CO1 |
| Week 2 | Channel development | Handnotes | CO5<br>CO6 |
| Week 3 | Channel widening | Handnotes | CO5<br>CO6 |
| Week 4 | Valley shape | Handnotes | CO5<br>CO6 |
| Week 5 | Stream terraces | Handnotes | CO5<br>CO6 |
| Week 6 | Alluvial flood plains | | CO5<br>CO6 |
| Week 7 | Deltas and alluvial fans | Handnotes | CO5<br>CO6 |
| Week 8 | Class Test 1 | | |
| Lecture 9 | Channel morphology | Handnotes | CO5<br>CO6 |
| Week 10 | Channel patterns and the river basin | Handnotes | CO5<br>CO6 |
| Week 11 | Channel patterns and the river basin | Handnotes | CO5<br>CO6 |
| Week 12 | Channel patterns and the river basin | Handnotes | CO5<br>CO6 |
| Week 13 | Class Test 2 | | |
| Week 14 | Review | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. "Physical and Engineering Geology", by S.K. Garg, Khanna Publishers
2. "Structural Geology" by Marland P. Billings, Prentice-Hall of India

**14.** References

1. **Lecture Materials** provided by course teachers

## 20.10 Description of Course CE 204

**SECTION A: General Information**

**1.** Course Title **Computer Programming Sessional**
**2.** Type of Course Basic Engineering (Compulsory)
**3.** Offered to Civil Engineering
**4.** Pre-requisite Course(s) None

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Programming concepts and algorithms; internal representation of data; elements of structured programming language: data types, operators, expressions, control structures, functions, pointers and arrays, input and output; concept of Object-Oriented Programming (OOP): encapsulation, inheritance, polymorphism and abstraction.**

**6.** Course Objectives

- Familiarize students with the control structures of programming language such as conditional statements, loops, functions
- Introduce students to the concept of object-oriented programming
- Develop the ability to think about the algorithm by analysing a problem and convert that into a computer program in C++ language

**7.** Knowledge required

Basic computer operating skill

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *depict* programming concepts and algorithms as well as write and run basic programs related to engineering (CO1) | PO(a), PO(b), PO(e) | C2 | Lectures, Homework | hands-on programming; MCQ |
| 2 | distinguish different data types, operators, expressions. (CO2) | PO(b), PO(e) | C4 | Lectures, Homework | hands-on programming; MCQ |
| 3 | *interpret* different control statements used in the programming language and apply the knowledge for solving engineering problems. (CO3) | PO(b), PO(e) | C3 | Lectures, Homework | hands-on programming; MCQ |
| 4 | *discover* the necessity of functions, pointers and arrays in the application of programming language. (CO4) | PO(b), PO(e) | C3 | Lectures, Homework | hands-on programming; MCQ |
| 5 | *explain* the concept of Object-Oriented Programming and gather sound knowledge about encapsulation, inheritance, polymorphism and abstraction. (CO5) | PO(b), PO(e) | C2 | Lectures, Homework | hands-on programming; MCQ |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to C++, Parts of a Program | Handout<br>Schaum's Ch. 01 | CO1 |
| Lecture 2 | Variables and Declaration, Input Output Operators, Data, Data-types | Handout<br>Schaum's Ch. 01 | CO1<br>CO2 |
| Lecture 3 | Arithmetic Operators, Conditional and Logical Operators<br>*Class Assessment 01* | Handout<br>Schaum's Ch. 02 | CO1<br>CO2<br>CO3 |
| Lecture 4 | Loops | Handout<br>Schaum's Ch. 03 | CO1<br>CO3 |
| Lecture 5 | Functions<br>*Class Assessment 02* | Handout<br>Schaum's Ch. 04 | CO1<br>CO4 |
| Lecture 6 | *Object Oriented Programming 01:*<br>Idea of class, passing objects to functions, Access modifier (public & private) | Handout<br>Schaum's Ch. 08 | CO1<br>CO5 |
| Lecture 7 | Mid-term quiz<br>*May include a hands-on portion in addition to MCQ* | --- | --- |
| Lecture 8 | *Object Oriented Programming 02:*<br>Constructor, Destructor, Inheritance | Handout<br>Schaum's Ch. 08 & 11 | CO1<br>CO5 |
| Lecture 9 | Introduction to 1-D and 2-D array<br>*Class Assessment 03* | Handout<br>Schaum's Ch. 05 | CO1<br>CO2 |
| Lecture 10 | Solving problems using array:<br>e.g., matrix manipulation, sorting | Handout<br>Schaum's Ch. 05 | CO1<br>CO2<br>CO3 |
| Lecture 11 | Pointers<br>*Class Assessment 04* | Handout<br>Schaum's Ch. 06 | CO1<br>CO4 |
| Lecture 12 | File Input-output<br>*Object Oriented Programming 03:*<br>Abstraction, Polymorphism<br>*Class Assessment 05* | Handout<br>Schaum's Ch. 12 & Ch. 11 | CO1<br>CO5 |
| Lecture 13 | Final Quiz<br>*May include a hands-on portion in addition to MCQ* | --- | --- |

Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment:
    - 4 to 5 hands-on Class Assessments using C++
    - Assessment will be based on either the topic taught on that day or topic taught on the previous day or combination of the two topics

- In addition to hands-on assessment, MCQ type assessments may be conducted in each class using google form/ google classroom.
- Assignment and/or homework will be provided to ensure the active engagement even outside class hours.

- Quizzes: Two quizzes will be administered. At least one exam will include a hand-on demonstration of C++ knowledge using a C++ IDE such as Code: Blocks. Both the quizzes will include an MCQ portion.

**11.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Assignment/ Homework/ File | 10% |
| Class Assessment | 40% |
| Quizzes (2 Nos: Hands-on and/or Written/MCQ) | 40% |

**12.** Textbook

1. Teach Yourself C++ by Herbert Schildt
2. Theory and Problems of Programming with C++ by John R. Habbard (Schaum's Outline Series)
3. Class Lecture Handout

**13.** References

**1.** Object Oriented Programming with C++ by E BalaguruSamy
**2.** MIT OpenCourseWare: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-096-introduction-to-c-january-iap-2011/

## 20.11 Description of Course CE 205

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Numerical Methods** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Systems of linear algebraic equations; interpolation and curve fitting; roots of equations; numerical differentiation; numerical integration; initial value problems; two-point boundary value problems; finite differences.**

**6.** Course Objectives

- To introduce with various numerical methods
- To apply numerical methods to solve mathematical and engineering problems

**7.** Knowledge required

- Preliminary knowledge in algebra, calculus, matrix.

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *distinguish* the difference between numerical and analytical solution methods | PO(a) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *apply* numerical methods to solve mathematical and engineering problems including finding roots of equations, solve differential equations, numerical integration and differentiation, solve algebraic equations, ordinary and partial differential equations | PO(a), PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 3 | *apply* least squares regression and interpolation to elucidate trends of datasets. | PO(a), PO(c) | C3 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan-1

| Sl | Topics | Reference | Corresponding COs |
|---|---|---|---|
| 1 | Introduction to Numerical Methods | Textbook, hand note | CO1 |
| 2. | Errors in numerical computing, truncation, round-off errors | Textbook, hand note | CO1<br>CO2<br>CO3 |
| 3 | Solution to algebraic and transcendental equations, bracketing methods: bi-section and Regula Falsi | Textbook, hand note | CO2<br>CO3 |
| 4 | Solution to algebraic and transcendental equations, open methods: iteration, Newton-Raphson, Secant, Modified Newton-Raphson | Textbook, hand note | CO2<br>CO3 |
| 5 | Curve fitting: Linear Least squares regression, polynomial regression, assessing the goodness-of-fit | Textbook, hand note | CO2<br>CO3 |
| 6 | Curve fitting: multiple linear regression, fitting non-linear curves | Textbook, hand note | CO2<br>CO3 |
| 7 | Solution of ODE initial value problems: Euler's method, error estimation in Euler's method | Textbook, hand note | CO2<br>CO3 |
| 8 | Solution of ODE initial value problems: Predictor-Corrector (Heun's) Method, Mid-point method, 4th Order Runge-Kutta method | Textbook, hand note | CO2<br>CO3 |
| 9 | Solution of ODE initial value problems: a system of ODE, higher order ODE. Solution of Boundary value problems: shooting method | Textbook, hand note | CO2<br>CO3 |
| 10 | Solution of Boundary value problems: method of finite differences. Solution of PDE: Laplace equations with Drichlet boundary conditions | Textbook, hand note | CO2<br>CO3 |
| 11 | Solution of PDE: Laplace equations with Neumann boundary conditions. Solution of parabolic PDE using explicit method | Textbook, hand note | CO2<br>CO3 |
| 13 | Solution of parabolic PDE using implicit methods | Textbook, hand note | CO2<br>CO3 |
| 14 | Class test-2 | | |
| 15 | Introduction to Numerical Methods | Textbook, hand note | CO1 |
| 16 | Solution of system of linear equations: Matrices, determinants | Textbook, hand note | CO1<br>CO2<br>CO3 |
| 17 | Solution of system of linear equations: Gauss elimination, Gauss Jordan | Textbook, hand note | CO2<br>CO3 |

| Sl | Topics | Reference | Corresponding COs |
|---|---|---|---|
| 18 | Solution of system of linear equations: Crout's method, matrix inversion | Textbook, hand note | CO2<br>CO3 |
| 19 | Interpolation: Graphical, Linear, Polynomial | Textbook, hand note | CO2<br>CO3 |
| 20 | Class Test and Interpolation: Gregory Newton, | | |
| 21 | Interpolation: Lagrangian, Finite Difference | Textbook, hand note | CO2<br>CO3 |
| 22 | Numerical Integration: Trapezoidal and Simpson's rules | Textbook, hand note | CO2<br>CO3 |
| 23 | Numerical Integration: Product of Integrals | Textbook, hand note | CO2<br>CO3 |
| 24 | Numerical Integration: Romberg's Quadrature, Integration over a rectangular domain | Textbook, hand note | CO2<br>CO3 |
| 25 | Numerical Integration: Gauss Quadrature | Textbook, hand note | CO2<br>CO3 |
| 26 | Numerical Differentiation: Mathematical molecules | Textbook, hand note | CO2<br>CO3 |
| 27 | Numerical Differentiation: Partial differentiation | Textbook, hand note | CO2<br>CO3 |
| 28 | Class test and review | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Numerical Methods for Engineers: Chapra & Canale References

**14.** Reference Materials:

a. Numerical Methods: E Balagurusamy
b. Introductory Methods of Numerical Analysis: Sastry
c. Numerical Analysis: Goel and Mittal
d. Numerical Mathematical Analysis: JB Scarborough

## 20.12 Description of Course CE 206

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Engineering Computation Sessional** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | CE 204 |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Introduction to hi-level computational programming tools; application to numerical analysis: basic matrix computation, solving systems of linear equations, non-linear equations, differential equations, interpolation and curve fitting, numerical differentiation, numerical integration; application to engineering problems: solving problems related to mechanics, numerical solution of equation of motion etc.

**6.** Course Objectives

- To teach the students fundamental of MATLAB programming and its application in engineering field
- To prepare the students so that they can apply MATLAB in their problem analysis and solving.

**7.** Knowledge required

Basic programming knowledge in any language, linear algebra

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | write basic codes to solve programming problems using MATLAB | PO(e) | C1 | Lectures, Homework | hands-on programming; examination; assignment |
| 2 | demonstrate competence in implementing hi-level programming tools to solve numerical computational problems (CO2) | PO(e) | C3, P5 | Lectures, Homework | hands-on programming quiz, assignment |
| 3 | apply hi-level computational tools to solve civil engineering related problems (CO3) | PO(b)<br>PO(e) | C3 | Lectures, Homework | hands-on programming, project |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | ✓ | | | | | | | | | | | | | | |
| CO-2 | | | | | | ✓ | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | MATLAB Fundamentals: Basic MATLAB syntax and commands, arrays, vectors, and matrix operation, plotting | Handout | CO1 |
| Lecture 2 | MATLAB Fundamentals: Loops- *while, for, if-else* scripting, function, file input-output<br>*Class Assessment 1* | Handout | CO1 |
| Lecture 3 | Roots of equations<br>*Group formation for Project (4 Students/group)* | Handout<br>Chapra (Chapter 5 & 6) | CO1<br>CO2 |
| Lecture 4 | Roots of equations<br>*Class Assessment 2* | Handout<br>Chapra (Chapter 5 & 6) | CO1<br>CO2 |
| Lecture 5 | System of linear equations | Handout<br>Chapra (Chapter 9 & 10) | CO1<br>CO2 |
| Lecture 6 | Curve fitting and interpolation<br>*Project proposal submission*<br>*Class Assessment 3* | Handout<br>Chapra (Chapter 14 & 17) | CO1<br>CO2<br>CO3 |
| Lecture 7 | Numerical differentiation and integration | Chapra (Chapter 19, 20, & 21) | CO1<br>CO2 |
| Lecture 8 | Solving ODE<br>*Class Assessment 4* | Handout<br>Chapra (Chapter 22, 23, & 24) | CO1<br>CO2 |
| Lecture 9 | Fourier Transform; Eigenvalues and eigenvectors | Handout<br>Chapra (Chapter 13, & 16) | CO1<br>CO2 |
| Lecture 10 | Basic statistics: descriptive statistics, distribution, hypothesis testing, regression model, ANOVA<br>*Class Assessment 5* | Handout | CO1<br>CO2 |
| Lecture 11 | Project presentation (8-10 minutes) + submission | -- | CO3 |
| Lecture 12<br>Week 10 or 11 | Quiz 1 (Hands-on Programming) | -- | CO2<br>CO3 |
| Week 13 | Quiz 2 (Written Test) | -- | CO1<br>CO2 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment:
  - 4 to 5 hands-on Class Assessments using MATLAB
  - Assessment will be based on either the topic taught on that day or topic taught on the previous day or combination of the two topics
  - In addition to hands-on assessment, MCQ type assessments may be conducted in each class using google form/ google classroom.
  - Assignment and/or homework will be provided to ensure the active engagement even outside class hours.
- Quizzes: Two nos quizzes will be administered. One of them will be a hands-on demonstration of coding and another one will be written exam.
- Project: A project will be assigned. The project should cover fundamental numerical analysis as well as their relevant application in the Civil Engineering field.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Assignment/ Homework/ File | 10% |
| Class Assessment | 30% |
| Quizzes (2 Nos: Hands-on and Written) | 35% |
| Project | 15% |

**13.** Textbook

1. **Applied Numerical Methods with MATLAB for Engineers and Scientists,** 4th edition**,** by Steven C. Chapra, McGraw-Hill Education. (Chapra)
2. Class Lecture Handout

**14.** References

4. **MATLAB Primer**, Mathworks Inc.

## 20.13 Description of Course CE 207

**SECTION A: General Information**

**1.** Course Title **Applied Mathematics for Engineers**
**2.** Type of Course Basic (Compulsory)
**3.** Offered to Civil Engineering
**4.** Pre-requisite Course(s) None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Review of differential equations; power series solution of differential equations and their applications: Frobenius method, Legendre's polynomials, gamma function, Bessel's function; integral form of differential equation and its application to engineering problem solving.**

**Fourier series and its properties, application to engineering problem solving; Fourier integral; Fourier transforms and their uses in solving boundary value problems; diffusion equation, wave equation, Laplace equation and their applications.**

**Application of statistical methods to engineering problems:**
**Random variables; discrete and continuous probability distributions; functions of random variables and derived distributions; expectation and moments of random variables; point estimation of distribution parameters: methods of moments and maximum likelihood, Bayesian analysis; confidence intervals; hypothesis tests; nonparametric statistical tests; simple and multiple linear regression and model selection; uncertainty and reliability analysis; project level decision making and quality control.**

**6.** Course Objectives

- To formulate and solve ODEs and PDEs for engineering problems
- To use probability to solve engineering problems
- To use Fourier method to solve engineering problems

**7.** Knowledge required

- Preliminary knowledge in probability, calculus, function, trigonometry.

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *formulate ordinary differential equations (ODEs) for engineering problems* | PO(a), PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *solve ordinary differential equations (ODEs) using power series.* | PO(a), PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 3 | *apply probability theories for random variables in mathematical models of engineering problems* | PO(a), PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 4 | *apply Fourier Transform to solve ODEs and PDEs* | PO(a), PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 5 | *determine Fourier series of periodic functions and Fourier integrals for non-periodic functions* | PO(a), PO(b) | C4 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to the course and review of parameters of differential equations | Handout | CO1 |
| Lecture 2 | Implication of linearity of ordinary linear differential equation | Handout, | CO1 |
| Lecture 3 | Even and odd functions | Handout, | CO5 |
| Lecture 4 | Periodic functions | Handout, | CO5 |
| Lecture 5 | Introduction to Fourier Series | Handout, | CO5 |
| Lecture 6 | Examples with application in differential equations | Handout, | CO5 |
| Lecture 7 | Fourier Integral; Class test on Fourier series | Handout, | CO4 |
| Lecture 8 | From Fourier integral to Fourier transform | Handout | CO4 |
| Lecture 9 | Fourier transforms of different functions | Handout, | CO4 |
| Lecture 10 | Application of Fourier transform in differential equation | Handout, | CO4 |
| Lecture 11 | Classification of partial differential equations. | Handout, | CO4 |
| Lecture 12 | Solution of parabolic equation; Class test on Fourier transform | Handout, | CO4 |
| Lecture 13 | Solution of elliptic equation | Handout, | CO4 |
| Lecture 14 | Solution of hyperbolic equation | Handout, | CO4 |
| Lecture 15 | Course Introduction: The Role of Statistics in the Engineering<br>Problem-Solving Process | Handout, | CO3 |
| Lecture 16 | Descriptive Statistics - Numerical and Graphical Methods | Handout, | CO 3 |
| Lecture 17 | Bayes' Theorem and Random Variables | Handout, | CO 3 |
| Lecture 18 | Discrete Random Variables and Probability Distributions | Handout, | CO 3 |
| Lecture 19 | Continuous Random Variables and Probability Distributions | Handout, | CO 3 |
| Lecture 20 | Joint Probability Mass and Density Functions | Handout, | CO 3 |
| Lecture 21 | Class Test | | CO 3 |
| Lecture 22 | Standard Probability Distributions: Bernoulli and Binomial | Handout, | CO 3 |
| Lecture 23 | Standard Probability Distributions: Poisson and Uniform | Handout, | CO 3 |
| Lecture 24 | Standard Probability Distributions: Normal and Exponential | Handout, | CO 3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 15-26 | Central Limit Theorem | Handout, | CO 3 |
| Lecture 27 | Quality Criteria for Estimates and Methods for Parameter Estimation | Handout, | CO 3 |
| Lecture 28 | Hypothesis Testing: Variance Known, Variance Unknown | Handout, | CO 3 |
| Lecture 29 | Review of Differential Equation | Handout, | CO1 |
| Lecture 30-31 | First order ordinary differential equation | Handout, | CO 1 |
| Lecture 32-33 | Separable variable, Exact Solution | Handout, | CO 1 |
| Lecture 34 | Class Test | | CO 1 |
| Lecture 35 | Introduction to Power series solution | Handout, | CO 2 |
| Lecture 36-37 | Legendre's Polynomials | Handout, | CO 2 |
| Lecture 38-39 | Bessel's Function | Handout, | CO 2 |
| Lecture 40 | Gamma Function | Handout, | CO 2 |
| Lecture 41-42 | Frobenius Method, Class Test | Handout, | CO 2 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Text book:

a. Advanced Engineering Mathematics by Greenberg, Second Edition, Prentice Hall
b. Introduction to Probability and Statistics for Engineers and Scientists, Fourth Edition, Academic Press

**14.** Reference materials:

a. Higher Engineering Mathematics by Bird, 6th Edition, Elsevier
b. Advanced Engineering Mathematics by Duffy, CRC Press
c. Advanced Engineering Mathematics by Jeffrey, HAP
d. Understanding Engineering Mathematics by Cox, Newnes
e. Advanced Engineering Mathematics by Kreyszig, 10th Ed., John Wiley

## 20.14 Description of Course CE 208

**SECTION A: General Information**

1. Course Title — **Quantity Surveying**
2. Type of Course — Basic Engineering (Compulsory)
3. Offered to — Civil Engineering
4. Pre-requisite Course(s) — None

**SECTION B: Course Details**

5. Course Content (As approved by the Academic Council)

   Earthwork excavation for roadway, earthwork computation from spot levels; estimation for residential building: estimation of slab, beam, column, footing; analysis of rates, specifications, costing of residential building; estimation and costing of septic tank; estimation and costing of underground water reservoir; estimation and costing of retaining wall; estimation and costing of slab culvert; estimation and costing of bridges; highways construction; estimation of steel truss; computer aided quantity estimation; construction site survey and estimation.

6. Course Objectives
   - To introduce the method of estimation to determine the amount of materials required for construction of different structures.
   - To find out the cost of materials required to construct a structure.

7. Knowledge required

   Civil Engineering drawing and interpretation of drawings, construction materials

8. Course Outcomes

   At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *compute* amount of earthwork excavation required for construction of highways and other structures. | PO(a) | C3 | Lectures, Class participation | Class test, final examination |
| 2 | *estimate* quantity of materials for different components of a residential building including both substructure and superstructure | PO(a), PO(b), PO(e) | C3, C4 | Lectures, Class participation | Class test, final examination |
| 3 | *estimate* quantity of materials for different structures such as slab culvert, retaining wall, steel truss etc. | PO(a), PO(b), PO(e) | C3, C4 | Lectures, Class participation | Class test, final examination |
| 4 | *prepare* a detailed bill of quantities | PO(a), PO(h) | C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | | | | |

10. Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction | Reference Manual, Lecture Slides | |
| Lecture 2 | Estimation of earthworks | Reference Manual , Lecture Slides | CO-1 |
| Lecture 3 | Estimation of residential building part-1 | Reference Manual, Lecture Slides | CO-1,CO-2 |
| Lecture 4 | Estimation of residential building part-2 | Reference Manual, Lecture Slides | CO-2 |
| Lecture 5 | Estimation of residential building part-3 and costing of residential buildings | Reference Manual, Lecture Slides | CO-2, CO-4 |
| Lecture 6 | Estimation of slab, footing | Reference Manual, Lecture Slides | CO-2, CO-4 |
| Lecture 7 | Mid quiz & Viva | | |
| Lecture 8 | Estimation of beam and column | Reference Manual, Lecture Slides | CO-2, CO-4 |
| Lecture 9 | Estimation of septic tank | Reference Manual, Lecture Slides | CO-2, CO-4 |
| Lecture 10 | Estimation of underground reservoir | Reference Manual, Lecture Slides | CO-2, CO-4 |
| Lecture 11 | Estimation of retaining wall | Reference Manual, Lecture Slides | CO-3, CO-4 |
| Lecture 12 | Estimation of slab culvert | Reference Manual, Lecture Slides | CO-3, CO-4 |
| Lecture 13 | Estimation of steel truss, highway construction, & computer aided quantity estimation | Reference Manual, Lecture Slides | CO-3, CO-4 |
| Lecture 14 | Final Quiz & Viva | | |

11. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least 6 class tests and class assessments will be administered. Best five of them will be counted towards grading.
- Viva: Mid Viva and Final Viva will be held during the Mid Quiz and Final Quiz week.
- Mid and Final quiz: Two comprehensive quizzes will be taken at mid and final week

12. Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Assessments & Class Test | 20% |
| Lab Report | 15% |
| Viva | 15% |
| Mid Quiz | 15% |
| Final Quiz | 25% |

13. Textbook

a. Quantity surveying manual provided in the class

## 20.15 Description of Course CE 210

**SECTION A: General Information**

**1.** Course Title — **Architectural, Engineering and Planning Appreciation**

**2.** Type of Course — Basic Engineering (Compulsory)

**3.** Offered to — Civil Engineering

**4.** Pre-requisite Course(s) — None

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

**Appreciation of architecture, mechanical engineering, urban and regional planning; environmental issues.**

**6.** Course Objectives

- To familiarize different branches of engineering
- To introduce problem associated with different aspects of civil engineering

**7.** Knowledge required

Preliminary knowledge in Civil Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *develop* knowledge on contemporary issues of different branches of engineering | PO(a) | C6 | Lectures, Class participation | Class test, Quiz |
| 2 | *identify* key considerable issues of various professions and *apply* with problems involved in different aspects of Civil Engineering | PO(b) | C3, P1 | Lectures, Class participation | Class test, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | √ | | | | | | | | | | | | | | | | | |
| CO-2 | | | √ | | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introductory Class | Handout | CO1 |
| Lecture 2-3 | Class Allocated for different respected professionals based on course requirement | Handout | CO1<br>CO2 |
| Lecture 4 | Class Test 1, Class Allocated for different respected professionals based on course requirement | Handout | CO1<br>CO2 |
| Lecture 5-6 | Class Allocated for different respected professionals based on course requirement | Handout | CO1<br>CO2 |
| Lecture 7 | Class Test 2, Class Allocated for different respected professionals based on course requirement | Handout | CO1<br>CO2 |
| Lecture 8-9 | Class Allocated for different respected professionals based on course requirement | Handout | CO1<br>CO2 |
| Lecture 10 | Class Test 3, Class Allocated for different respected professionals based on course requirement | Handout | CO1<br>CO2 |
| Lecture 11-12 | Class Allocated for different respected professionals based on course requirement | Handout | CO1<br>CO2 |
| Lecture 13 | Presentation | | CO2 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least 3 class tests will be administered.
- Presentation: A brief ppt presentation will be held on relevant topics

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Reports | 30% |
| Presentation | 40% |

**13.** Textbook: N/A

**14.** References

1. Lecture Slides provided by respective guests and professionals.

## 20.16 Description of Course CE 211

### SECTION A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **Mechanics of Solids 1** |
| **2.** | Type of Course | Structural Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | CE 101 |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Concepts of stress and strain, generalized Hooke's law; deformations due to tension, compression and temperature change; frame statics: reactions, axial force, shear force and bending moments; axial force, shear force and bending moment diagrams of beams using method of section and summation approach; elastic analysis of circular shafts in torsion, solid noncircular and thin walled tubular members subjected to torsion, flexural and shear stresses in beams; shear center; closely coiled helical springs**

**6.** Course Objectives

- To introduce problems associated with stress and strain
- To enable students to draw a axial force, shear force and bending moment diagrams of beams using method of section and summation approach
- To perform elastic analysis of circular shaft in torsion
- To solve the problems related to flexural stress, shear stress and shear center

**7.** Knowledge required

Preliminary knowledge in mechanics

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *draw* the free body diagrams of beams and frames and hence sketch shear force, axial force and bending moment diagrams for structures subjected to different types of loading. | PO(a)<br>PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 2 | *calculate* the stress and strain of structural members under axial load and internal pressure. | PO(a)<br>PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 3 | *solve* for bending stress-strain and shear stress using flexural stress and shear stress formula. | PO(a)<br>PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 4 | *determine* the torsional stress of solid, circular shafts and rectangular sections as well as hollow tubes. | PO(a)<br>PO(b) | C4 | Lectures, Class participation | |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Mechanics of Solids I<br>Free Body and Internal Linear Force, Concept of Stress at a point, Stress Components, Stress Tensor, Differential equations of equilibrium. | Handout | CO1 |
| Lecture 2 | Axial-Shear-Bearing Stress, Deterministic Design of Members: Axially Loaded Bars, Allowable Stress. Stress concentration. | Handout | CO1<br>CO2<br>CO3 |
| Lecture 3-4 | Solution of problems covering topics of Stress. | Handout | CO2<br>CO3 |
| Lecture 5-6 | Strain at a point, Stress-Strain diagrams for different type of material. Hooke’s Law: Modulus of Elasticity. Poisson’s Ratio. Generalized Hooke’s Law. Thermal strain and deformation. Idealized stress-strain relations for different material behavior. Stain energy for uni-axial loading. | Handout | CO1<br>CO2<br>CO3 |
| Lecture 7-8 | Solution of problems covering topics of Strain. | Handout | CO1<br>CO2 |
| Lecture 9 | Class test-1. Topic: Stress and Strain | | |
| Lecture 10-12 | Shear force, axial force and bending moment diagrams: Classification of supports, free body diagrams. Internal hinges and their behaviour. Definition of positive shear, axial force and moments. | Handout | CO1<br>CO3 |
| Lecture 13-15 | Construction of shear force, axial force and bending-moment diagrams for beams using method of sections. | Handout | CO1<br>CO2<br>CO3 |
| Lecture 16-19 | Construction of shear force and bending-moment diagrams for beams using Integration method: Shear Diagrams by Integration of the loadings, Moment Diagrams by Integration of the Shear. | Handout | CO1<br>CO3 |
| Lecture 20 | Effect of Concentrated Moment on Moment Diagrams. | Handout | CO1 |
| Lecture 21 | Class test-2. Topic: Shear force, axial force and bending moment diagrams | | |
| Lecture 22-23 | Flexural stress in beams. Kinematic Assumptions for deformation of beams subjected to bending. Derivation of Flexural stress formula for beams. Modifications to Flexural stress formula to cater for beams made with different modulus of elasticity. | Handout | CO1<br>CO3 |
| Lecture 24-25 | Solution of problems covering topics of Flexural stress. | Handout | CO3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 26-27 | Shear Stress in beams.<br>Review of relation between shear and bending moment diagrams of beams. Effect on bending stress between two sections of a beam due to change in vertical shear. Shear Flow. Shear Flow and Shear Stress formula. | Handout | CO1<br>CO3 |
| Lecture 28 | Class test-3. Topic: Flexural stress in beams | | |
| Lecture 29-31 | Solution of nailed and glued joint problems using shear stress formula. Calculation of vertical shear stress over different type of beam sections. | Handout | CO1<br>CO3 |
| Lecture 32-33 | Shear Stress in Beam Flanges. Shear Centre. | Handout | CO1<br>CO3 |
| Lecture 34 | Torsion<br>Torsion of circular elastic bars, basic assumptions, Torsion formula for circular elastic bars and its limitations. Relation between work, torque and frequency. | Handout | CO1<br>CO4 |
| Lecture 35 | Class test-4. Topic: Shear Stress in beams. | Handout | |
| Lecture 36 | Calculation of shear stress for circular solid and hollow sections subjected to torque. | Handout | CO1<br>CO4 |
| Lecture 37-40 | Design of Circular Members in Torsion for Strength. Stress Concentrations in shafts subjected to torque and having change in diameter. Angle of Twist of Circular Members. Torsion of solid non circular members. Thin walled hollow members subjected to torque. | Handout | CO1<br>CO4 |
| Lecture 41-42 | Introduction to Pressure Vessels. Thin walled Pressure Vessels. Longitudinal and hoop stress in pressure vessels. Connection design for pressure vessels. | Handout | CO1<br>CO2 |

**11.** Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Engineering Mechanics of Solids: Egor P. Popov
2. Strength of Materials: Andrew Pytel & Ferdinand L. Singer
3. Mechanics of Materials: Ferdinand P. Beer, E. Russell Johnston, Jr, John T. DeWolf and David F. Mazurek

**14.** References

CE 211 Lecture Notes

## 20.17 Description of Course CE 212

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Structural Mechanics and Materials Sessional** |
| **2.** | Type of Course | Structural Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

**Tension, direct shear and impact tests of mild steel specimen; slender column test; static bending test; hardness test of metals; helical spring test; determination of shear centre; study of structural models: truss, beam frame.**

**6.** Course Objectives

- To determine different mechanical properties of mild steel specimens and metals.
- To analyse the performance of slender column and bending of beams.
- To determine different geometric properties of sections.
- To enable students to interpret the behaviour of structural models under load.

**7.** Knowledge required

Preliminary knowledge in mechanics

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *outline* the fundamental tests of common engineering materials used in construction practices. | PO(a) | C1 | Lectures, Class participation | Class test |
| 2 | *measure* dimensions of specimens and operate lab instruments required for testing | PO(e)<br>PO(i) | C1, C2, P4 | Lectures, Class participation | Class test |
| 3 | *determine* mechanical properties of steel and timber specimens by applying knowledge of standards | PO(a)<br>PO(i) | C1, C2 | Lectures, Class participation | Class test |
| 4 | *compare* results of tests to interpret the applicability for different purposes. | PO(a) | C1, C2 | Lectures, Class participation | |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | | | | ✓ | | | | | | | | | | | | | |
| CO-3 | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Material Testing (First five experiments) | Handout | CO1 |
| Lecture 2 | Tension Test of Mild Steel Specimen and Class Assessment-1 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 3 | Direct Shear Test of Metal Specimens and Class Assessment-2 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 4 | Hardness Test of Metal Specimens and Class Assessment-3 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 5 | Impact Test of Metal Specimens and Class Assessment-4 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 6 | Tension & Bend Test of MS Rebar and Class Assessment-5 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 7 | Introduction to Material Testing (Last five experiments) | Handout | CO1 |
| Lecture 8 | Compression Test on Timber Specimen and Class Assessment-6 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 9 | Test of Helical Spring and Class Assessment-7 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 10 | Slender Column Test for Different End Conditions and Class Assessment-8 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 11 | Static Bending Test of Timber Beam and Class Assessment-9 | Handout | CO2<br>CO3<br>CO4 |
| Lecture 12 | Tension Test of Steel Coupon and Class Assessment-10 | Handout | CO2<br>CO3<br>CO4 |

**11.** Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Lecture: Two lectures will be given for 10 experiments, covering five experiments per lecture.
- Lab Report: A comprehensive report will be submitted by the students upon completion of each experiment which will be graded.
- Class Test: 10 (Ten) class assessments will be administered each day prior to the commencement of the scheduled experiment.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 15 |
| Lab Report | 60 |
| Class Assessment | 75 |

**13.** Textbook

Theory and Practice of Testing the Strength of Materials
Authors: Dr. Ishtiaque Ahmed

**14.** References

- ASTM A370-Mechanical Testing of Steel Products
- ASTM A125- Helical Spring Testing
- ASTM D143- Standard Test Methods for Small Clear Specimens of Timber

## 20.18 Description of Course CE 213

### SECTION A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **CE213: Mechanics of Solids II, 3.00 Cr.Hr.** |
| **2.** | Type of Course | Structural Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | CE 211 |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Symmetric and unsymmetrical bending of beams; stresses due to axial load and bending; stress transformation, Mohr's circle of stresses; beam deflection by direct integration and moment area method; elastic buckling of columns; elastic strain energy; cable theorem and cable supported structures, thin walled pressure vessels.**

**6.** Course Objectives

- To introduce problems associated with symmetric and unsymmetrical bending of beams.
- To enable students to solve problems of stresses due to axial load and bending.
- To familiarize students with principles of stress transformation.
- To familiarize students with Mohr’s circle of stress along with application in solving problems.
- To determine deflection of beams using direct integration and moment area methods.
- To solve problems related to elastic buckling of columns.
- To familiarize students with concepts of elastic strain energy and its application
- To solve problems related to cable supported structures and thin-walled pressure vessels.

**7.** Knowledge required

Preliminary knowledge in mechanics

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *Comprehend* combined stress equation and *apply* these formulae to determine normal stress in structural members and the location of the plane of zero stress resulting from axial loading and/or biaxial bending. | PO(a)<br>PO(b) | C3 | Lectures, Class participation | Class test, and /or final examination |
| 2 | *determine* the stress and their direction at a point in any orientation in a body through stress transformation methods and the orientations of principal | PO(a)<br>PO(b) | C3 | Lectures, Class participation | final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | stresses and maximum shear stresses due to applied loads. | | | | |
| 3 | *Apply* Mohr's circle of stress to graphically *solve* stress transformation problems. | PO(a) PO(b) | C3 | Lectures, Class participation | Class test, and /or final examination |
| 4 | *determine* the deflections of beams subjected to different loadings using the concepts integration and moment-area theorems. | PO(a) PO(b) | C4 | Lectures, Class participation | Class test, and /or final examination |
| 5 | *formulate* the critical buckling load of columns for different end conditions and *use* them to calculate buckling loads of compression members in structures. | PO(a) PO(b) | C4 | Lectures, Class participation | final examination |
| 6 | *state* and *formulate* cable theorem and *apply* this theorem to determine stresses, strain and other parameters of cables. | PO(a) PO(b) | C3 | Lectures, Class participation | final examination |
| 7 | *determine* the different states of stress, strain and other parameters pressure vessels. | PO(a) PO(b) | C3 | Lectures, Class participation | final examination |
| 8 | *apply* the concept of elastic strain energy to *determine* various deformation components in simple structural elements. | PO(a) PO(b) | C4 | Lectures, Class participation | Class test, and /or final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| CO-4 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-7 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-8 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Mechanics of Solids II. Review of different types of loading, support, internal forces, stresses (axial, bending and shear), deformation and strain. | Handout | CO1 |
| Lecture 2-6 | Combined stresses considering axial load and bending moment (uni-axial and biaxial) Solution of problems for Symmetric and un-symmetric beam bending | Handout | CO1 |
| Lecture 7 | Class test-1. Topic: Symmetric and un-symmetric bending of beams | | |
| Lecture 8 | Introduction to transformation of stress and derivation of equations for Transformation of Stresses in Two-Dimensional Problems | Handout | CO2 |
| Lecture 9-10 | Principal Stresses in Two-Dimensional Problems, Maximum Shear Stresses in Two-Dimensional Problems and Mohr's Circle of Stress for Two-Dimensional Problems | Handout | CO2, CO3 |
| Lecture 11-12 | Solution of problems covering classes 8-10 | | CO2, CO3 |
| Lecture 13 | Class test-2. Topic: Stress Transformation | | |
| Lecture 14 | Beam Deflection by Direct Integration: derivation of equations. Alternative forms of equations, boundary conditions. | Handout | CO4 |
| Lecture 15-17 | Calculation of deflection of beams using method of integration for various support condition, loadings and stiffness. | Handout | CO4 |
| Lecture 18 | Beam Deflections by Moment-area Method: derivation of equations. Interpretation of signs for angle change and tangential deviations | Handout | CO4 |
| Lecture 19-21 | Calculation of deflection of beams using Moment-area Method for various support condition, loadings and stiffness. | Handout | CO4 |
| Lecture 22 | Class test-3. Topic: Deflection of Beams | | |
| Lecture 23 | Buckling of Columns, Examples of Instability, Euler Load for Columns with Pinned Ends | Handout | CO5 |
| Lecture 24-26 | Euler Load for Columns with different end restraints, Limitations of the Euler Formulas, Generalized Euler Buckling Formulas | Handout | CO5 |
| Lecture 27-30 | Elastic Strain Energy for: Axial Stress (from normal load and bending moment), Shear Stress and Torsional Stress. Calculation of Energy and Deformation using energy methods. | Handout | CO8 |
| Lecture 31 | Class test-4. Topic: Elastic Strain Energy | | |
| Lecture 32-34 | Cables, Introduction to various cable type of structures, Shape of Cables, General Cable theorem, solution of problems with concentrated loadings | Handout | CO6 |
| Lecture 35-38 | Cable under uniformly distributed load: Cable Shape, Cable length, Cable Tension, Cable Stretch. Solution of problems for Statically Determinate Suspension Bridges | Handout | CO6 |
| Lecture 39-41 | Combined stresses for thin walled pressure vessels | Handout | CO7 |
| Lecture 42 | Review class | | |

**11.** Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

a) Engineering Mechanics of Solids: Egor P. Popov, Pearson
b) Strength of Materials: Andrew Pytel & Ferdinand L. Singer, Harpercollins College Div.
c) Mechanics of Materials: Russell C. Hibbeler, Pearson

**14.** References

CE 213 Lecture Notes

**20.19 Description of Course CE 300**

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Professional Training in Civil Engineering (1.00 Cr. Hr.)** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Level 3/ Term II, Civil Engineering Students |
| **4.** | Pre-requisite Course(s) | Minimum Credit Requirement: 80.00 Cr. Hr |

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Involvement as a trainee in a Civil Engineering related industry/ projects/ firms to gather knowledge on state-of-the-art practices of Civil Engineering.**

**6.** Course Objectives

- Students will be able to learn professional and ethical responsibility
- Students will be able to observe professional skills
- Students will be able to improve communication skills

**7.** Knowledge required

Preliminary knowledge in civil engineering structures

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *Comprehend* professional and ethical responsibility in a real-life project setup | PO(f),<br><br>PO(h) | C3 | Instructions, Project demonstration & participation | Reports, Evaluation/Feedback |
| 2 | *comprehend and study* professional skills from the observations of real projects | PO(l) | C2, A3 | Instructions, Project demonstration & participation | Reports, Evaluation/Feedback |
| 3 | *communicate* with professionals in a well scientific manner | PO(j) | C5, A2 | Instructions, Project demonstration & participation | Reports, Evaluation/Feedback |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-2 | | | | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | | | | | | | | | | | | | | | | |

**10. Lecture Plan**
Not Applicable

**11.** Assessment Strategy

- Participation: Participation and attendance will be recorded in every class.
- Continuous Assessment: Reports, Evaluation & Feedback

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Participation | 20% |
| Reports | 50% |
| Evaluation & Feedback | 30% |

**13.** Textbook
Not applicable

**14.** References
Not applicable

## 20.20 Description of Course CE 301

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Professional Practices and Communication** |
| **2.** | Type of Course | Basic Engineering Practice (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Project, its characteristic feature, project life cycle; type of contracts; procurement regulations and law; documents for procurement of works, goods and services and their application; contract risk and contract responsibility; insurances; tender procedure; claims, disputes and arbitration procedure; measures for reducing fiduciary risks. Introduction to communication concepts, modes of communication, methods of effective communication; writing reports; oral presentation of reports; writing proposals; preparing effective business messages; conducting meetings; strategies for effective speaking and successful inter personal communication; job application process, interviews and follow-ups; an introduction to the code of ethics for engineers.**

**6.** Course Objectives

- To introduce students to a wide range of practical aspects in the profession of civil engineering

- To introduce the basic concept of project and project risk
- To introduce the issues related with ethics for engineering profession
- To familiarize the students about the process and regulatory framework for public procurement
- To provide the students the basic working knowledge on preparing procurement documents and evaluation for procurement
- To provide the students the basic knowledge of effective written and oral communications

**7.** Knowledge required

Basic comprehension and language skills

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *decide* on procurement method for a particular application based on the nature and value of Works/Goods and *prepare* Procurement Document under the framework of public procurement Act and Regulation. | PO(k) | C5; C3 | Lectures, Class participation | Class test, final examination |
| 2 | *apply* the Procurement Process by arranging a competitive bidding. | PO(j) | C3 | Lectures, Class participation | Class test, final examination |
| 3 | *Understand* the principles of effective verbal, non-verbal and written communication for engineering professionals and know how to *prepare* presentations and reports | PO(j) | C1; C2 | Lectures, Class participation | Class test, final examination |
| 4 | *discuss* the concept of project and project development, the characteristics of a project, contract clauses and formats and comprehend fiduciary risk and *interpret* insurance and bonds as a risk management tool | PO(k) | C2 | Lectures, Class participation | Class test, final examination |
| 5 | *follow* the basic principles underlying Code of Ethics for Engineers in professional practice | PO(f) | C4; C5 | Lectures, Class participation | Class test, final examination |
| 6 | *explain* the attributes of the civil engineering profession | PO(f) | A3 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | √ | | | | | | | | | | | | | | | | |
| CO-2 | | | | | √ | | | | | | | | | | | | | | | |
| CO-3 | | | | | √ | | | | | | | | | | | | | | | |
| CO-4 | | | | | √ | | | | | | | | | | | | | | | |
| CO-5 | | | | | | | √ | | | | | | | | | | | | | |
| CO-6 | | | | | | | √ | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Act and Regulation in relation to Public Procurement Act (PPA) and Public Procurement Regulation (PPR) | Handout | CO1 |
| Lecture 2 | Provisions of PPA and PPR on<br>(i)Basic terminologies used in procurement<br>(ii)Applicability of PPA<br>(iii) Flowchart of Tendering Process | Handout, Masters | CO1 |
| Lecture 3 | (i)The procurement process: role of Tender Opening and Tender Evaluation Committees;<br>(ii)Tender Evaluation Process<br>(iii) Procurement Plan and its purpose | Handout, Masters | CO1<br>CO2 |
| Lecture 4 | National Competitive Tender and International Competitive Tender Procurement Methods for Works and goods and their applicability; | Handout, Masters | CO2 |
| Lecture 5 | Details advantages and disadvantages of various methods of procurements | Handout, Masters | CO1 |
| Lecture 6 | Procurement Methods for intellectual services | Handout, Masters | CO1 |
| Lecture 7 | Claims, disputes and arbitration procedure; | Handout, Masters | CO1 |
| Lecture 8 | Importance of specification, Attributes of good specification, General and Particular Specification | Handout, Masters | CO1 |
| Lecture 9 | Specification of civil construction items; specification of goods items. | Handout, Masters | CO1 |
| Lecture 10 | Importance of BoQ; Preparation of BoQ for civil construction items and goods items. | Handout, Masters | CO1 |
| Lecture 11-12 | Elements of Tender Document; Priority of contract documents. Discussion of GCC and PCC. | Handout, Masters | CO1 |
| Lecture 13 | Review | | CO1<br>CO2 |
| Lecture 14 | Class Tests | | CO1<br>CO2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 15 | Definition and aspects of Civil Engineering as a profession; Attributes of Civil Engineering Profession; Historical inheritance | Handout | CO4<br>CO6 |
| Lecture 16 | Project: Definition, Characteristics and Lifecycle | Handout, Masters | CO4 |
| Lecture 17 | Project Development, Professional engagement in project development, Participants in project development | Handout, Masters | CO4 |
| Lecture 18-19 | Flow of work in project development: Predesign, Design, Bid, Construct, Occupy and Decommission | Handout, Masters | CO4 |
| Lecture 20 | Design thinking in project development, Quality control plan | Handout, Masters | CO4 |
| Lecture 21 | Contract law, Contract formation, Typical contract formats | Handout, Masters | CO4 |
| Lecture 22 | Contract clauses, Contract in project delivery system, | Handout, Masters | CO4 |
| Lecture 23 | Dealing with contract risk & risk management | Handout, Masters | CO4 |
| Lecture 24-25 | Insurance: Professional liability insurance, Liability insurance coverage, Specific concerns for professional liability insurance | Handout, Masters | CO4 |
| Lecture 26 | Bonds: Types of bonds, Important aspects of bond inquiry; Fiduciary Risk | Handout, Masters | CO4 |
| Lecture 27 | Review | Handout, Masters | CO4 |
| Lecture 28 | Class Tests | | CO4 |
| Lecture 29 | Introduction to Communication | Handout | CO3 |
| Lecture 30 | The Seven C’s of Effective Communication | Handout, Masters | CO3 |
| Lecture 31 | Preparing Effective Business Messages | Handout, Masters | CO3 |
| Lecture 32 | Types of Messages | Handout, Masters | CO3 |
| Lecture 33 | Reports | Handout, Masters | CO3 |
| Lecture 34 | Oral presentation of Written Reports | Handout, Masters | CO3 |
| Lecture 35 | Proposals | Handout, Masters | CO3 |
| Lecture 36 | Informal Oral Communication | Handout, Masters | CO3 |
| Lecture 37 | Interpersonal Communications | Handout, Masters | CO3 |
| Lecture 38 | Business and Group Meetings | Handout, Masters | CO3 |
| Lecture 39 | Communication and Legal Issues | Handout, Masters | CO3 |
| Lecture 40 | Job Application Process, Vocabulary, Grammar, Punctuation and Style | Handout, Masters | CO3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 41 | Code of Ethics for Engineers | Handout, Masters | CO5 |
| Lecture 42 | Class Tests | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Public Procurement Act, Bangladesh National Assembly, Dhaka, 2006
2. Public Procurement Regulation, Central Procurement Technical Unit (CPTU), IMED, Ministry of Planning, Dhaka, 2008.
3. PWD Schedule of Rates 2014 for Civil Works (or updated version), Public Works Department, Dhaka.
4. Civil Engineer's Handbook of Professional Practice by Karen Lee Hansen & Kent E. Zenobia
5. Effective Business Communication, 7th Ed., Herta A. Murphy, Herbert W. Hilderbrandt, Jane P. Thomas
6. Engineering Ethics, 3rd Ed., Charles A. Fleddernamm

**14.** References

1. Standard Procurement Documents prepared by Central Procurement Technical Unit (CPTU) is the administering authority for PPA 2006 and PPR 2008.
   Website: http://www.cptu.gov.bd/
2. Professional Communication in Engineering, H. E. Sales
3. Engineering your Future, 2nd Ed., Stuart B. Walch

## 20.21 Description of Course CE 302

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Professional Practices and Communication Sessional** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Application of communication theory and professional practice approaches in a controlled class room environment; this may include case study analysis, role playing, preparing small reports and proposals, class room presentations and individual reports etc.**

**6.** Course Objectives

- To teach students preparation of write-ups, posters, project proposals, tender documents, meeting minutes, cv to enhance professional and communication skills
- To provide training on developing oral and written communication skills
- To teach students to develop teamwork.

**7.** Knowledge required

Preliminary knowledge in Civil Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *develop* oral and written communication skills by presentation of various assigned tasks and interaction of audiences | PO(j) | C6 | Lectures, Class participation | Presentation |
| 2 | *prepare* write-ups, posters, project proposals, tender documents, meeting minutes, cv to enhance professional and communication skills | PO(i), PO(j) | C6 | Lectures, Class participation | Presentation, Reports |
| 3 | *identify* and solve community problems as a part of assigned projects | PO(i) | C4, C3, P1 | Lectures, Class participation | Report |
| 4 | *develop* teamwork and leadership skills by guiding designated teams in fulfilling the to-dos of a project | PO(i) | C6 | Lectures, Class participation | Presentation, Reports |
| 5 | *arrange* meetings, mock interviews, surveys and interaction sessions based on different assigned tasks | PO(i) | C6 | Lectures, Class participation | Meeting |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | √ | | | | | | | | | | | | | | |
| CO-2 | | | | | √ | | | | | | | | | | | | | | | |
| CO-3 | | | | | | √ | | | | | | | | | | | | | | |
| CO-4 | | | | | | √ | | | | | | | | | | | | | | |
| CO-5 | | | | | | √ | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction /Lecture on Oral Presentation | Handout | CO1 |
| Lecture 2 | Individual presentation & submission of a small write-up | Handout | CO1 |
| Lecture 3 | Introduction to assigned project and lecture on contents and techniques of writing an effective project proposal along with performing SWOT analysis. | Handout | CO1<br>CO2 |
| Lecture 4 | Lecture on poster presentation and introduction to sample posters. | Handout | CO2 |
| Lecture 5 | Poster Presentation and evaluation | | CO2 |
| Lecture 6 | Presentation on proposal for the assigned project. | | CO3<br>CO4<br>CO5 |
| Lecture 7 | Lecture on conducting effective meetings | Handout | CO6 |
| Lecture 8 | Conducting meeting and evaluation. | | CO6 |
| Lecture 9 | Lecture on contents of a tender document & elements of a Bill Of Quantity (BOQ) | Handout | CO2 |
| Lecture 10 | Presentation on tender as procuring entity & submission of BOQ. | Handout | CO2<br>CO4 |
| Lecture 11 | Tender bidding process /Presentation on tender as the tenderer | | CO2<br>CO4 |
| Lecture 12 | Lecture on the contents and techniques of writing an effective CV and stages of an interview. | Handout | CO5 |
| Lecture 13 | Submission of CV and attending a mock-interview. | | CO5 |
| Lecture 14 | Combined presentation of the selected project proposals from individual sections and selection of top three proposals. | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Presentation: A brief ppt and poster presentation will be held on relevant topics
- Meeting: A meeting will be held on relevant topics
- Interview: A mock interview will be held

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Presentation | 15% |
| Report | 10% |
| CV | 15% |
| Tender Document | 10% |
| Meeting | 10% |
| Poster | 10% |
| Tender | 20% |

**13.** Textbook

1. Public Procurement Act, Bangladesh National Assembly, Dhaka, 2006

2. Public Procurement Regulation, Central Procurement Technical Unit (CPTU), IMED, Ministry of Planning, Dhaka, 2008.

3. PWD Schedule of Rates 2014 for Civil Works (or updated version), Public Works Department, Dhaka.

**14.** References

1. Tender Document (National) For Procurement of Works (Open Tendering / Limited Tendering Method) Central Procurement Technical Unit Implementation Monitoring and Evaluation Division, Ministry of Planning.
2. Public Works Department Rate Schedule, 2018.

## 20.22 Description of Course CE 311

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Structural Analysis and Design II** |
| **2.** | Type of Course | Structural Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | CE 213 |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Stability and determinacy of structures; Analysis of statically determinate frames, trusses and arches; Influence lines; Moving loads on beams, frames and trusses; Wind and earthquake loads, code provisions. Approximate analysis of statically indeterminate structures: Mill bents, braced trusses; Portal method, cantilever method and vertical load analysis of multi storied building frames; building drift.**
**Deflection of beams, trusses and frames by virtual work method; approximate analysis of suspension bridges.**

**6.** Course Objectives

- To familiarize students with determinacy and stability of structures.
- To perform analysis of statically determinate frames, truss, arches.
- To enable students to draw influence lines for moving loads on beams.
- To introduce the concepts for approximate analysis of statically indeterminate strictures.
- To enable students to determine deflection of beams, trusses and frames by virtual work method.

**7.** Knowledge required

Preliminary knowledge in mechanics

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *evaluate* determinacy of structures including truss, frames, and arches | PO(a) | C5 | Lectures, Class participation | Class test, final examination |
| 2 | *analyze* statically determinate truss, frames, suspension bridge, and arches | PO(a) | C4 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 3 | *apply* various methods to analyze indeterminate structures including braced trusses and multi-storied building frames | PO(a)<br>PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 4 | *develop* influence lines for various structures including truss, beams, and frames and determine response of structures under moving load. | PO(a)<br>PO(b) | C6 | Lectures, Class participation | Class test, final examination |
| 5 | *calculate* deflections of beams, trusses, and frames by using virtual work method | PO(a) | C4 | Lectures, Class participation | Class test, final examination |
| 6 | *estimate* wind and earthquake load for buildings and bridges as per BNBC guidelines | PO(a)<br>PO(b) | C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | | | | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | | | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-6 | | | | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1 | Introduction to various structural systems and loads | Text Book | |
| 2-4 | Analysis of Statically determinate Frames | Text Book | CO1<br>CO2 |
| 5-6 | Analysis of Statically determinate Trusses | Text Book | CO1<br>CO2 |
| 7 | Analysis of Statically determinate Arches | Text Book | CO1<br>CO2 |
| | Class Test 1 | | |
| 8 | Approximate Analysis of Mill bent Structure | Text Book | CO3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 9-10 | Approximate analysis of Indeterminate Trusses | Text Book | CO3 |
| 11 | Approximate analysis of Indeterminate frames for Vertical Loads | Text Book | CO3 |
| 12-14 | Approximate analysis of Indeterminate frames for Lateral Loads | Text Book | CO3 |
| | Class Test 2 | Handout | |
| 15-18 | Development of influence lines for statically determinate beams and application of influence line subjected to moving load. | Books/ Handout | CO4 |
| 19 | Development of influence lines for floor girders. | Books/ Handout | CO4 |
| 20 | Development of influence lines for truss structures. | Books/ Handout | CO4 |
| 21 | Class Test 1 | | |
| 22-24 | Determination of maximum reactions, shears, and moments of beams under series of wheel loads. | Books/ Handout | CO4 |
| 25 | Determination of absolute maximum moment of beams under series of wheel loads. | Books/ Handout | CO4 |
| 26-27 | Determination of maximum member forces of a truss structure under series of wheel loads. | Books/ Handout | CO4 |
| 28 | Determination of maximum panel reactions, shears, and moments of a floor girder under series of wheel loads. | Books/ Handout | CO4 |

**11.** Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

Elementary Structural Analysis, Norris Charles Head,
Structural Analysis by R. C. Hibbeler, 8th eds.

**14.** References

Bangladesh National Building Code, 2006 eds.

## 20.23 Description of Course CE 315

**SECTION A: General Information**

**1.** Course Title — **Design of Concrete Structures I**
**2.** Type of Course — Structural Engineering (Compulsory)
**3.** Offered to — Civil Engineering
**4.** Pre-requisite Course(s) — None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Fundamental behaviour of reinforced concrete and loads on structure; introduction to strength design and alternate design methods; flexural design of beams (singly reinforced, doubly reinforced, T-beam) using strength design method; shear, diagonal tension and torsion of beams; bond and anchorage of reinforcement and its detailing; design of one- way slabs; design of two-way edge supported slabs.**

**6.** Course Objectives

- To acquaint students with the behaviour of reinforced concrete structures under load.
- To introduce to students with the design methodologies adopted for design of elements in building.
- To enable students to design members of a building under flexure using strength design method with detailing.

**7.** Knowledge required

Preliminary knowledge in mechanics

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | Appraise the concept of USD and alternate (WSD) design methods for flexure and mechanics involved during different stages of a loaded beam ie. uncracked, cracked, failure. | PO(a) | C5 | Lectures, Class participation | Class test, final examination |
| 2 | Design different (singly reinforced, doubly reinforced and T-beam) reinforced concrete beams for flexure. | PO(a)<br>PO(b)<br>PO(c) | C6 | Lectures, Class participation | Class test, final examination |
| 3 | Conceive the shear and torsion behavior and design reinforced concrete beams for shear and torsion. | PO(a)<br>PO(b)<br>PO(c) | C5, C6 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 4 | Develop all types of reinforcement detail drawings of reinforced concrete beams that account for development length, anchorage, and splicing of reinforcing bars. | PO(a)<br>PO(b)<br>PO(c) | C6 | Lectures, Class participation | |
| 5 | Design and develop drawings for one-way and two-way edge supported slabs. | PO(a)<br>PO(b)<br>PO(c) | C6 | Lectures, Class participation | |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-4 | ✓ | | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1 | Introduction to Reinforced Concrete, Different Structural forms, Evolution of Reinforced Concrete | Handout | CO1 |
| 2 | Loads: Dead, Live and their estimation | Handout | CO1 |
| **3** | Loads: wind, earthquake loads and their estimation | Handout | CO1 |
| 4 | Strength design and safety: Capacity-Demand concept, Variability and safety, Safety provisions of ACI and BNBC | Handout | CO1 |
| 5 | Fundamental assumptions, Mechanics of axially loaded RC members under different loading stages | Handout | CO1 |
| **6** | Fundamental assumptions, Mechanics of axially loaded RC members under different loading stages | | CO1 |
| 7 | Behaviour of homogeneous beams, Behaviour of RC beams under increasing loads, | Handout | CO1 |
| 8 | Calculation of stresses at different loading stages- uncracked and cracked elastic | Handout | CO1 |
| 9 | Calculation of stresses at different loading stages- failure (strength), Balanced condition, | Handout | CO1 |
| 10 | Design of singly reinforced rectangular beams, | Handout | CO2 |
| 11 | provisions for under-reinforced beams, phi factors, minimum and maximum reinforcement ratio, Design aids | | CO2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 12 | Singly reinforced beam | Handout | CO2 |
| 13 | Singly reinforced beam | Handout | CO2 |
| 14 | Singly reinforced beam | Handout | CO2 |
| 15 | Singly reinforced beam | Handout | CO2 |
| 16 | Singly reinforced beam | Handout | CO2 |
| 17 | Singly reinforced beam | Handout | CO2 |
| 18 | Doubly reinforced Beam | Handout | CO2 |
| 19 | Doubly reinforced Beam | Handout | CO2 |
| 20 | Doubly reinforced Beam | Handout | CO2 |
| 21 | Doubly reinforced Beam | Handout | CO2 |
| 22 | T- Beams | Handout | CO2 |
| 23 | T- Beams | Handout | CO2 |
| **24** | T- Beams | Handout | CO2 |
| 25 | Shear, diagonal tension and torsion of beams | Handout | CO3 |
| 26 | Shear, diagonal tension and torsion of beams | Handout | CO3 |
| 27 | Shear, diagonal tension and torsion of beams | Handout | CO3 |
| 28 | Shear, diagonal tension and torsion of beams | Handout | CO3 |
| 29 | Shear, diagonal tension and torsion of beams | Handout | CO3 |
| **30** | Shear, diagonal tension and torsion of beams | Handout | CO3 |
| 31 | Bond and anchorage | Handout | CO4 |
| 32 | Bond and anchorage | Handout | CO4 |
| 33 | Bond and anchorage | Handout | CO4 |
| 34 | Bond and anchorage | Handout | CO4 |
| **35** | Bond and anchorage | Handout | CO4 |
| 36 | One-way slabs | Handout | CO5 |
| 37 | One-way slabs | Handout | CO5 |
| 38 | One-way slabs | Handout | CO5 |
| 39 | Two-way slabs | Handout | CO5 |
| 40 | Two-way slabs | Handout | CO5 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 41 | Two-way slabs | Handout | CO5 |
| 42 | Review | | |

**11.** Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Design of Concrete Structures: Darwin, Dolan and Nilson, 15th Ed

**14.** References

1. Structural Concrete- Theory and Design: Hassoun, Al-Manaseer 7th Ed
2. Reinforced Concrete- Mechanics & Design: Wight & McGregor 6th Ed
3. Bangladesh National Building Code, 1994/2006 and 2020
4. ACI 318-08: Building Code Requirements for Structural Concrete and Commentary

## 20.24 Description of Course CE 316

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Bridge Design Sessional** |
| **2.** | Type of Course | Structural Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Design and detailing of a slab bridge; design and detailing of a balanced cantilever bridge; design and detailing of a PC Girder Bridge.**

**6.** Course Objectives

- To teach students the design methodology adopted for different types of bridge design.
- To prepare the students to identify the problems faced in bridge design.
- To provide hands on training in preparing detailed drawings required for bridge design.

**7.** Knowledge required

Theoretical background in behaviour of reinforced concrete.

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *Identify* the structural elements of a slab bridge, balanced cantilever bridge and PC girder bridge. | PO(a)<br>PO(b)<br>PO(d) | C1 | Lectures, Homework | |
| 2 | *Analyse* various structural components of slab bridge, balanced cantilever bridge and PC girder bridge. | PO(a)<br>PO(b)<br>PO(d) | C4 | Lectures, Homework | |
| 3 | *Design* various structural components of slab bridge, balanced cantilever bridge and PC girder bridge. | PO(a)<br>PO(b)<br>PO(c) | C6 | Lectures, Homework | |
| 4 | *Generate* the detailing of various structural components of slab bridge, balanced cantilever bridge and PC girder bridge. | PO(a)<br>PO(b)<br>PO(c) | C6 | Lectures, Homework | |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | | ✓ | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | ✓ | | | | | | ✓ | ✓ | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | ✓ | ✓ | | | | ✓ |
| CO-4 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | ✓ | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1-5 | Introduction RC Cantilever Bridge | Handout | CO1<br>CO2<br>CO3<br>CO4 |
| Lecture 6 | RC Slab Bridge | Handout | CO1<br>CO2<br>CO3<br>CO4 |
| Lecture 7 | Mid Quiz and Viva | | |
| Lecture 8-12 | PC Girder Bridge | Handout | CO1<br>CO2<br>CO3<br>CO4 |
| Lecture 13 | Final Quiz and Viva | | |

**11.** Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least five eight class assessments will be administered. Best out of them will be counted towards grading.

- Quiz: A comprehensive mid and final quiz will be held at the middle and end of the Term.
- Viva: A comprehensive mid and final viva will be held at the middle and end of the Term.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Lab Report | 20% |
| Class Assessment | 20% |
| Mid Quiz | 20% |
| Final Quiz | 20% |
| Mid Viva | 5% |
| Final Viva | 5% |

**13.** Textbook

Design of Modern Highway Bridges by Narendra Tally

**14.** References

1. Lecture Notes on CE 316

## 20.25 Description of Course CE 317

**SECTION A: General Information**

| | |
|---|---|
| 1. Course Title | **Design of Concrete Structures II** |
| 2. Type of Course | Structural Engineering (Compulsory) |
| 3. Offered to | Civil Engineering |
| 4. Pre-requisite Course(s) | CE 315 |

### SECTION B: Course Details

5. Course Content (As approved by the Academic Council)

**Design of column supported slabs; introduction to floor systems; design of columns under uniaxial and biaxial loading, introduction to slender column; structural design of footings, pile caps; seismic detailing; shear wall; structural forms; introduction to prestressed concrete; analysis and preliminary design of prestressed beam sections.**

6. Course Objectives

- To acquaint students with the different types of floor systems.
- To introduce to students with the design methodologies adopted for design of elements in building.
- To enable students to design compressive members under different types of loading.
- To introduce to students the analysis and design methodologies for prestressed concrete.

7. Knowledge required

Preliminary knowledge in mechanics

8. Course Outcomes

At the end of the course a student should be able to

| **CO No.** | **CO Statement** | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| 1 | *design* of reinforced concrete columns under uniaxial and biaxial loading | PO(a)<br>PO(c) | C6 | Lectures, Class participation | |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 2 | *analyze* the stresses and moments developed in slabs and columns | PO(a)<br>PO(b) | C4 | Lectures, Class participation | |
| 3 | *construct* structural designs of single footings, combined footings, raft foundations and pile caps | PO(a)<br>PO(b)<br>PO(c) | C6 | Lectures, Class participation | |
| 4 | *prepare* seismic detailing for beams and columns | PO(a)<br>PO(j) | C6 | Lectures, Class participation | |
| 5 | *evaluate* and construct a shear wall | PO(a)<br>PO(b)<br>PO(c) | C5, C6 | Lectures, Class participation | |
| 6 | *describe* the basic concepts of prestressed concrete: pretensioning, posttensioning, loss of prestress, high strength materials | PO(a) | C2 | Lectures, Class participation | |
| 7 | *investigate* and draft a preliminary prestressed beam section using the three fundamental concepts of prestressing | PO(a)<br>PO(b)<br>PO(c) | C4, C6 | Lectures, Class participation | |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-4 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-7 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |

10. Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1 | Introduction | | |
| 2 | Materials | Handout | CO6 |
| **3** | Materials | Handout | CO6 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 4 | Pre-stress system | Handout | CO6 |
| 5 | Loss of Pre-stress | Handout | CO6 |
| **6** | Loss of Pre-stress | Handout | CO6 |
| 7 | Loss of Pre-stress | Handout | CO6 |
| 8 | Analysis of section for flexure | Handout | CO6 |
| 9 | Analysis of section for flexure | Handout | CO6 |
| 10 | Analysis of section for flexure and class test -1 | Handout | CO6 |
| 11 | Analysis of section for flexure | Handout | CO6 |
| 12 | Analysis of section for flexure | Handout | CO6 |
| 13 | Preliminary design and class test -2 | Handout | CO7 |
| 14 | Preliminary design | Handout | CO7 |
| 15 | Axially loaded column | Handout | CO1 |
| 16 | Axially loaded column | Handout | CO1 |
| **17** | Axially loaded column- problems , tied column | Handout | CO1 |
| 18 | Axially loaded column- problems, spiral column and ct-1 | Handout | |
| 19 | Compression and uniaxial bending | Handout | CO1<br>CO2 |
| **20** | Compression and uniaxial bending-problem | Handout | CO1<br>CO2 |
| 21 | Compression and uniaxial bending-problem | Handout | CO1<br>CO2 |
| 22 | Compression and uniaxial bending-charts and ct-2 | Handout | |
| 23 | Compression and biaxial bending – loaded column | Handout | CO1<br>CO2 |
| 24 | Compression and biaxial bending –reciprocal column | Handout | CO1<br>CO2 |
| 25 | Slender column and shear wall | Handout | CO5 |
| 26 | Shear wall problem | Handout | CO5 |
| 27 | Seismic detailing | Handout | CO4 |
| 28 | Seismic detailing | Handout | CO4 |
| 29 | Floor and roof slab system-introduction | Textbook | CO2 |
| 30 | DDM method | Textbook | CO2 |
| 31 | DDM method - Design | Textbook | CO2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 32 | DDM method - Design and Shear design in flat plates and flat slabs | Textbook | CO2 |
| 33 | Shear design in flat plates and flat slabs | Textbook | CO2 |
| 34 | Shear design in flat plates and flat slabs | Textbook | CO2 |
| 35 | Footings and foundations –introduction and ct-1 | Textbook | |
| 36 | Footing-square | Textbook | CO3 |
| 37 | Footing – rectangular | Textbook | CO3 |
| 38 | Combined footing-grid/strip | Textbook | CO3 |
| 39 | Combined footing-two column footing | Textbook | CO3 |
| 40 | Combined footing- raft/mat | Textbook | CO3 |
| 41 | Pile cap | Textbook | CO3 |
| 42 | Pile cap | Textbook | CO3 |

11. Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

12.Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

13.Textbook

1. Design of concrete structures –David Darwin, Charles W. Dolan and Arthur H. Nilson $15^{th}$ Edition
2. Design of prestressed concrete structures – T.Y. Lin

14. References

1. Structural concrete – theory and design – Hassoun, Al-Manaseer , $7^{th}$ Edition
2. Reinforced concrete – mechanics and design – Wight and McGregor, $6^{th}$ Edition

## 20.26 Description of Course CE 319

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **CE319: Design of Steel Structures, 3.00 Cr.hr.** |
| **2.** | Type of Course | Structural Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

**Behavioral principles and design of structural steel; design of tension members, bolted and welded connections; compression members; residual stress, local buckling, effective length; flexural members; lateral torsional buckling; design of beam-columns; connection design, moment connections, column bases; detailing of steel structures.**

**6.** Course Objectives

- To acquaint students with behavior and design of steel structure.
- To introduce to students with the design methodologies adopted for design of members and connections in building.
- To enable students to determine different types of failure modes of the structure and members.
- To introduce to students the analysis of base connections.

**7.** Knowledge required: Preliminary knowledge in mechanics.

**8.** Course Outcomes: At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *Learn* and *understand* the special and unique features of structural steel design including AISC LRFD and ASD principles, limit states and design loading conditions. | PO(a), PO(b), PO(c) | C2 | Lectures, Class participation | Final Examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 2 | *Learn* various limit states of tension members, *design* and proportion tension members | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Class test, Final Examination |
| 3 | *Analyze* the effect of residual stresses in the behavior of tension members | PO(a), PO(b), PO(c) | C2 | Lectures, Class participation | Final Examination |
| 4 | *Learn* various limit states of simple bolted connections, *design* and proportion simple bolted connections subject to axial forces. | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Final Examination |
| 5 | *Learn* various limit states of welded connections, *design* and proportion simple welded connections subject to axial forces. | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Class test, Final Examination |
| 6 | *Learn* and *understand* the buckling behavior and limit states of compression members, *design* and proportion compression members | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Class test, Final Examination |
| 7 | *Understand* lateral torsional buckling and other limit states of beams, *design* and proportion flexural members. | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Class test, Final Examination |
| 8 | *Understand* the behavior of beam columns, *design* and proportion beam-columns. | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Final Examination |
| 9 | *Understand* the limit states and behavior of simple and moment connections, *design* and detail simple connections and moment connections. | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Final Examination |
| 10 | *Understand* the limit states and behavior of columns bases, *design* and detail column bases subject to axial compression. | PO(a), PO(b), PO(c) | C4 | Lectures, Class participation | Final Examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation;
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-4 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-5 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-6 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-7 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-8 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-9 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-10 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |

10. Lecture Plan

| Lectures | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1, 2, 3 | Introduction | Text Book, Handout | CO1 |
| 4, 5, 6, 7 | Tension members | Text Book, Handout | CO1, CO2, CO3 |
| 8 | CT-1 | Text Book, Handout | CO1, CO2 |
| 9, 10, 11, 12 | Bolted Connections | Text Book, Handout | CO1, CO4 |
| 13, 14, 15, 16 | Welded connections | Text Book, Handout | CO1, CO5 |
| 17 | CT-2 | Text Book, Handout | CO1, CO4 |
| 18, 19, 20, 21 | Compression members | Text Book, Handout | CO1, CO6 |
| 22 | CT-3 | Text Book, Handout | CO1, CO6 |
| 23, 24, 25, 26, 27, 28 | Flexural members | Text Book, Handout | CO1, CO7 |
| 29 | CT-4 | Text Book, Handout | CO1, CO7 |
| 30, 31, 32 | Beam Columns | Text Book, Handout | CO1, CO8 |
| 33, 34, 35, 36, 37, 38 | Connections | Text Book, Handout | CO1, CO9, CO10 |
| 39, 40, 41, 42 | Reserved for make-up classes due to holidays and other disruptions. | | |

11. Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

12.Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

13.Textbook: Steel Structures: Design and Behavior, 5th Ed.
Authors: Salmon, Johnson and Malhas

14. References: AISC Steel Construction Manual, $14^{th}$ Ed.

## 20.27 Description of Course CE 320

**SECTION A: General Information**

**1.** Course Title **Steel Structures Design Sessional**

**2.** Type of Course Structural Engineering (Compulsory)

**3.** Offered to Civil Engineering

**4.** Pre-requisite Course(s) CE 319

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Analysis and design of low rise moment frame building for gravity and wind loads; Design of members, connections and columns bases.

**6.** Course Objectives

- To teach students design methodology of various components of a steel moment frame building.

- To prepare the students on how to design steel moment frame buildings considering gravity and wind loads as per code provisions.
- To provide hands on training on relevant tools for modelling and analysis of steel moment frame building under various loads.

**7.** Knowledge required

Theoretical background in behaviour and design of steel members when subjected to loads.

**8.** Course Outcomes

At the end of the course a student should be able to

| **CO No.** | **CO Statement** | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| 1 | *Identify* the key parameters/ factors for analysis and design of a Low-Rise Steel Building | PO(a) | C1 | Lectures, Homework | Assignment |
| 2 | *Define* the applicable load cases and load combinations for the steel Buildings as per code | PO(a) | C1 | Lectures, Homework | Quiz, Assignment |
| 3 | *Analyse* Low-Rise Steel Building through computer software | PO(b)<br>PO(e) | C4 | Lectures, Homework | Assignment |
| 4 | *Design* various components of the Low-Rise Steel Building | PO(c) | C5 | Lectures, Homework | Quiz, Assignment |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| **Class No.** | **Topics** | **References** | **Corresponding CO(s)** |
|---|---|---|---|
| Lecture 1 | Introductory class on steel structures design | Handout | |
| Lecture 2 | (i) Applicable gravity and wind load calculations as per BNBC.<br>(ii) Purlin and bracing design. | Handout | CO1<br>CO2 |
| Lecture 3 | Hands on training on software for analysis of Low rise steel frame. | Handout | CO1<br>CO2<br>CO3 |
| Lecture 4 | Hands on training on software for analysis of Low rise steel frame. | Handout | CO1<br>CO2<br>CO3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 5 | Hands on training on software for analysis of Low rise steel frame. | | CO1<br>CO2<br>CO3 |
| Lecture 6 | (i) Problem Identification<br>(ii) Conceptual Design<br>(iii) Model Development<br>(iv) Load calculation and application | Handout | CO1<br>CO2<br>CO3 |
| Lecture 7 | Mid-Term Quiz + Viva | | |
| Lecture 8 | (i) Analysis of frame<br>(ii) Force calculation for design of different components. | Handout | CO3<br>CO4 |
| Lecture 9 | Beam and Column Design | Handout | CO2<br>CO3<br>CO4 |
| Lecture 10 | Connection Design | Handout | CO2<br>CO3<br>CO4 |
| Lecture 11 | Anchor and Bracing Design | Handout | CO2<br>CO3<br>CO4 |
| Lecture 12 | Final Quiz +Viva | | |

**11.** Assessment Strategy

- Class Participation: Class attendance will be recorded in every class.
- Class Test: At least five eight class assessments will be administered. Best out of them will be counted towards grading.
- Quiz: A comprehensive mid and final quiz will be held at the middle and end of the Term.
- Viva: A comprehensive mid and final viva will be held at the middle and end of the Term.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Lab Report | 20% |
| Class Assessment | 20% |
| Viva (2) | 20% |
| Quiz (2) | 30% |

**13.** Textbook

1. Design of Steel Structures – Edwin H. Gaylord, Jr. Charles N. Gaylord, James E. Stallmeyer, Mcgraw-Hill International Editions
2. Structural Steel Design – Lambert Tall, John Wiley & Sons.
3. Steel Structures – Charles G. Salmon & Joh E. Johnson, Index Educational Publishers.

**14.** References

1. Lecture Notes on CE 320.
2. AISC Steel Construction Manual, 14th Ed.
3. BNBC 2020.

## 20.28 Description of Course CE 331

### SECTION A: General Information

**1.** Course Title — **Environmental Engineering I**

**2.** Type of Course — Environmental Engineering (Compulsory)

**3.** Offered to — Civil Engineering

**4.** Pre-requisite Course(s) — None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Introduction to Environmental Engineering: ecology and environment; climate change; biodiversity; energy and environment.

Water Supply Engineering: introduction; water supply scenario in Bangladesh and SDG targets; water demands; water supply sources; ground water exploration: aquifer properties and ground water flow, well hydraulics, water well design, drilling, construction and maintenance; water demand for rural communities; shallow hand tubewells, deep tubewells, deep set pumps, rainwater harvesting, and alternative water supplies for problem areas.

Surface water collection and transportation; head works; pumps and pumping machineries; water distribution systems; analysis and design of distribution network; fire hydrants; water meters; leak detection; unaccounted for water.

Water quality requirements; water treatment: plain sedimentation, coagulation, flocculation, filtration, disinfection; miscellaneous treatment methods; low cost treatment methods for rural communities; water safety plans.

**6.** Course Objectives

The objective of the course is to introduce the basic concepts of environmental engineering to the students. Students will learn about the interaction of man-made and natural environment and how external drivers (climate change) affect this interaction. The course will discuss basic concepts of water supply engineering, water quality, water treatment requirements and processes in the context of developing countries. The water quality challenges of Bangladesh and existing low-cost technologies to extract and treat water will also be covered.

**7.** Knowledge required

Preliminary knowledge in environmental engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *depict* the inter-relationship among various environmental compartments (ecology, biodiversity) and environmental forcers (climate change, GHG) under the context of Bangladesh | PO(a)<br>PO(g) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *explain* various components and aspects of traditional water supply systems from source to consumer with a particular focus on low-income and urban communities | PO(a)<br>PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 3 | *estimate* various parameters pertinent to the design of traditional water supply systems with a special emphasis on groundwater-based systems | PO(a)<br>PO(b)<br>PO(c) | C2 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 4 | *compute* flows in piped water distribution systems using iterative methods | PO(b)<br>PO(e) | C3 | Lectures, Class participation | Class test, final examination |
| 5 | *comprehend* basic principles of different engineered systems of water purification as well as the significance of different drinking water quality parameters | PO(a)<br>PO(b) | C2 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | | | | ✓ | | | | | | | | | ✓ | | | | |
| CO-2 | | | | ✓ | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| CO-3 | | | | ✓ | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| CO-4 | | ✓ | | | ✓ | | | | | | | | | | | ✓ | | | | |
| CO-5 | ✓ | | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Environmental (Background of Civil, Sanitary, Public Health and Environmental) Engineering | Handout | CO1 |
| Lecture 2 | Ecology and Environment, Biodiversity (genetic diversity, species diversity and ecosystem diversity), Benefits of biodiversity, Loss of biodiversity in Bangladesh. | Handout | CO1 |
| Lecture 3 | Climate Change: Greenhouse gases and its effect, Causes of climate change, Climate Change in the context of Bangladesh, General impacts of climate change in Bangladesh | Handout | CO1 |
| Lecture 4 | Introduction to water supply and sanitation, Elements of public water supply, Planning a municipal water supply system, | Handout | CO2 |
| Lecture 5 | Water Demand: Water Consumption categories, Factors affecting water consumption, Water demand for rural communities | Handout | CO2 |
| Lecture 6 | Estimating future water demand, population prediction to estimate water requirements | Handout | CO3 |
| Lecture 7 | Class Test-1,<br>Hydrologic cycle and water availability, Ground and surface Water sources | Handout | CO2 |
| Lecture 8 | Suitability of water sources with regards to quantity and quality, Choice of a source for water supply | Handout | CO2<br>CO3 |
| Lecture 9-10 | Groundwater exploration: Confined and unconfined aquifer properties, Groundwater flow, Well hydraulics, Interference between multiple extraction wells | Handout | CO3 |
| Lecture 11 | Water well design, well drilling, construction and maintenance of wells | Handout | CO3 |
| Lecture 12 | Alternative water supplies for problem areas in Bangladesh: shallow hand tubewells, Deep-set intermediate technologies, Deep tube-wells, Infiltration gallery, Pond sand filters, Rainwater harvesting | Handout | CO2 |
| Lecture 13 | Non-revenue water: Unbilled authorized consumption, Apparent losses and Engineering losses, Leak detection methods. | Handout | CO3 |
| Lecture 14 | Review | | |
| Lecture 15 | Introduction. Objectives, history, Essential elements of water supply system | Handout | CO2 |
| Lecture 16 | Surface water collection and transportation - intake systems | Handout | CO2 |
| Lecture 17 | Transportation of water, pressure pipes, corrosion of metal pipes, scale formation | Handout | CO2<br>CO3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 18 | Forces action on pipes, strength of pipes, pipe joints, pipe laying | Handout | CO2<br>CO3 |
| Lecture 19 | Class test-2,<br>pumps and pumping machinery | Handout | CO3 |
| Lecture 20 | Pump design | Handout | CO3 |
| Lecture 21 | Hydraulics of flow | Handout | CO4 |
| Lecture 22 | Water distribution system, classification, pressure requirements in water distribution system | Handout | CO3<br>CO4 |
| Lecture 23 | Economic dimension of a cylindrical overhead reservoir - problem solution | Handout | CO3 |
| Lecture 24 | Layout of water distribution system | Handout | CO3 |
| Lecture 25 | Design of water distribution system | Handout | CO3<br>CO4 |
| Lecture 26 | Class test-3,<br>water safety plan | Handout | CO5 |
| Lecture 27 | Water safety plan | Handout | CO5 |
| Lecture 28 | Overall review | | |
| Lecture 29 | History of water treatment, Significance of water quality parameters: Suspended solids, turbidity, color, odor and taste, TDS, alkalinity | Handout | CO5 |
| Lecture 30 | Significance of water quality parameters: Alkalinity, hardness, fluoride, Sulphate, metals, organics, nutrients (C, N, P) | Handout | CO5 |
| Lecture 31 | Significance of water quality parameters: indicator organisms - Total and Fecal coliform, water quality standards, comparison of water quality and treatment processes of different sources of water | Handout | CO5 |
| Lecture 32 | Class test-4,<br>Engineered systems of water purification: Gas transfer (aeration), basic principles, factors affecting effectiveness of liquid-gas contact systems | Handout | CO5 |
| Lecture 33 | Solids separation: sedimentation theory and principles, clarifier design parameters, removal efficiency of discrete and flocculent settling | Handout | CO5 |
| Lecture 34 | Coagulation chemistry, theory of destabilization of colloidal particles, factors affecting coagulation and flocculation | Handout | CO5 |
| Lecture 35 | Softening process and chemical reactions, split treatment, softening basins, water stabilization and re-carbonation | Handout | CO5 |
| Lecture 36 | Filtration theory and practice, characteristics, advantages and disadvantages of Roughing filter, Slow sand and Rapid sand filter, Filter operational difficulties | Handout | CO5 |
| Lecture 37 | Ion exchange practice, advantages and disadvantages, breakthrough and regeneration in the Ion Exchange process, | Handout | CO5 |
| Lecture 38 | Membrane processes: Reverse Osmosis principles and applications, Electro-dialysis. | Handout | CO5 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 39 | Disinfection chemistry and kinetics, Chemical oxidant demand and break point chlorination | Handout | CO5 |
| Lecture 40 | Adsorption mechanisms and applications (GAC and PAC), Manganese removal: theory and criteria | Handout | CO5 |
| Lecture 41 | Arsenic and Iron removal: theory, reactions and criteria | Handout | CO5 |
| Lecture 42 | Class test-5,<br>Overall review | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of Academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **Environmental Engineering** by Peavy, Rowe, Tchobanoglous
2. **Water Supply Engineering** by M.A. Aziz
3. **Water Supply and Sanitation for rural and low income urban communities** by M. Feroze Ahmed and Md. Mujibur Rahman
4. **Water Safety Plan (WSP): a risk based approach for water safety** by Ashraf Ali, Muhammad, Mahbuboor R. Choudhury and Mujibur Rahman
5. Class Lecture Handout

**14.** References

1. **Introduction to Environmental Engineering**, Fifth edition, by Mackengie L. Davies and David A. Cornwell, Mc Graw Hill Education.
2. CE 332: Environmental Engineering Sessional Class notes, BUET

## 20.29 Description of Course CE 332

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Environmental Engineering Laboratory** |
| **2.** | Type of Course | Environmental Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Water and wastewater sampling techniques, sample preservation, physical, chemical and biological tests of water and wastewater; breakpoint chlorination, alum coagulation, sampling and laboratory analysis of air, sampling and laboratory analysis of soil and solid waste.

**6.** Course Objectives

- To provide a clear concept on water and wastewater sampling technique and sample preservation.
- To provide a fundamental concept of physical, chemical, and biological tests for assessing the quality of water and wastewater.
- To make familiar with the Standard Code Specifications and Testing methods for the laboratory experiment.
- To develop report writing skills, analytical skills, and oral presentation skills for interpreting and analysing experimental data.

**7.** Knowledge required

Preliminary knowledge in environmental engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *apply* sampling and preservation techniques for environmental samples | PO(d)<br>PO(i) | C2 | Lectures, Class participation | Class Assessment, Lab Report, Viva, Quiz |
| 2 | *determine* physical, chemical, and biological characteristics of water and wastewater | PO(d)<br>PO(e)<br>PO(i) | C4 | Lectures, Class participation | Class Assessment, Lab Report, Viva, Quiz |
| 3 | *estimate* design parameters for treatment of water and wastewater | PO(b)<br>PO(d)<br>PO(i) | C5 | Lectures, Class participation | Class Assessment, Lab Report, Viva, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | | ✓ | | | | | | | | | | | | |
| CO-2 | | | | | | ✓ | | ✓ | | | | | | | | | | | | |
| CO-3 | | | ✓ | | | | | ✓ | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Water sampling methods for lab analysis | Laboratory Manual | CO1 |
| Lecture 2 | Determination of pH, color, turbidity, total solids, dissolved solids, and suspended solids in water | Laboratory Manual | CO2 |
| Lecture 3 | Determination of carbon dioxide, alkalinity, and hardness in water | Laboratory Manual | CO2 |
| Lecture 4 | Determination chloride and iron in water | Laboratory Manual | CO2 |
| Lecture 5 | Viva-1 and Quiz-1 | | |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 6 | Estimation of organic pollution load through determination of BOD and COD | Laboratory Manual | CO2 |
| Lecture 7 | Chemical coagulation of water: Alum coagulation | Laboratory Manual | CO2<br>CO3 |
| Lecture 8 | Determination of residual chlorine and chlorine demand: Break point chlorination | Laboratory Manual | CO2<br>CO3 |
| Lecture 9-10 | Determination arsenic in water; Determination of Total Coliform and Fecal Coliform for microbiological water quality analysis | Laboratory Manual | CO2 |
| Lecture 11 | Model test for estimation of design parameters for water treatment | Laboratory Manual | CO3 |
| Lecture 12 | Model test for estimation of design parameters for wastewater treatment | Laboratory Manual | CO3 |
| Lecture 13 | Review | | |
| Lecture 14 | Viva-2 and Quiz-2 | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Assessment: A short class assessment will be administered prior to each lecture. Average marks obtained from those will be counted towards grading.
- Viva: Two oral viva sessions will be held at the middle and the end of the term respectively.
- Quiz: Two comprehensive sessional quizzes will be held at the middle and the end of the term respectively following the guideline of Academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Lab Report | 15% |
| Class Assessment | 20% |
| Viva | 10% |
| Quiz | 45% |

**13.** Textbook

1. **Environmental Engineering Laboratory Manual**, Department of Civil Engineering, Bangladesh University of Engineering and Technology (BUET).
2. **Chemistry for Environmental Engineering and Science**, 4th & 5th Editions by Clair N Sawyer, Perry L. McCarty, Gene F. Parkin, McGraw Hill

**14.** References

1. **Standard methods for the examination of water and wastewater**. American Public Health Association (APHA), Washington DC, USA.

## 20.30 Description of Course CE 333

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Environmental Engineering II** |
| **2.** | Type of Course | Environmental Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Introduction to waste management: liquid waste, solid waste, air and noise pollution.

Wastewater Engineering: introduction; estimation of wastewater; wastewater collection systems; hydraulics of sewer; design, construction and maintenance of sanitary sewer and storm drainage system; sewer appurtenances.

Wastewater characteristics; microbiology of wastewater; wastewater treatment and disposal; sludge treatment and disposal.

Sanitation and health; sanitation coverage in Bangladesh and SDG targets; onsite sanitation system including Fecal Sludge Management (FSM), pour-flush toilets, septic tank system, Anaerobic Baffled Reactor (ABR); Decentralized Wastewater Treatment Systems (DEWATS).

Plumbing system.

Sustainability of water and sanitation services, introduction to EIA.

**6.** Course Objectives

- To make students understand the principles of different types of wastewater treatment system.
- To describe the importance and scopes of sustainability and community management of water and sanitation services.

**7.** Knowledge required

Preliminary knowledge in environmental engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *Assess* and *select* suitable water and sanitation services | PO(a)<br>PO(b)<br>PO(f)<br>PO(g) | C6 | Lectures, Class participation | Class test, final examination |
| 2 | *Plan and design* plumbing system | PO(b)<br>PO(c) | C5 | Lectures, Class participation | Class test, final examination |
| 3 | *classify* sanitation systems including fecal sludge management system | PO(a)<br>PO(f)<br>PO(g) | C2 | Lectures, Class participation | Class test, final examination |
| 4 | *design* onsite sanitation systems, including pour-flush latrines and septic tanks | PO(c)<br>PO(f)<br>PO(g) | C6 | Lectures, Class participation | Class test, final examination |
| 5 | *estimate* the wastewater generation, design flow rates, and *design* wastewater conveyance system. | PO(b)<br>PO(c) | C2, C5 | Lectures, Class participation | Class test, final examination |
| 6 | *comprehend* the principles and operations of different types of wastewater treatment systems | PO(a)<br>PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 7 | *comprehend* characteristics of wastewater and *classify* wastewater treatment processes and systems | PO(a)<br>PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 8 | *determine* design parameters of different unit operations and processes for wastewater treatment systems, and *identify* options for sludge treatment and disposal | PO(a)<br>PO(c) | C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| CO-2 | | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | | |
| CO-3 | | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | ✓ | | | | | | | | | | | | | |
| CO-5 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-6 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| CO-7 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| CO-8 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| **Class No.** | **Topics** | **References** | **Corresponding CO(s)** |
|---|---|---|---|
| Lecture 1-4 | Sustainability of water and sanitation services | Handout | CO1 |
| Lecture 5-8 | Participatory development approach in water and sanitation sector | Handout | CO1 |
| Lecture 9-11 | Community management in water and sanitation services | Handout | CO1 |
| Lecture 12-13 | Plumbing system design | Handout | CO2 |
| Lecture 14 | Class test-1 | | |
| Lecture 15-16 | Typical Wastewater/Effluent Treatment Processes; Objectives of sampling from a WWTP/ETP; Grab and Composite sampling, planning for composite sampling | Handout | CO6<br>CO7 |
| Lecture 17-19 | Wastewater Conveyance System: Types of wastewater conveyance systems; Sources of wastewater; Estimation of infiltration and inflow; Corrosion of sewer systems; Sulfide attack, hydrogen sulfide corrosion | Handout | CO3<br>CO5 |
| Lecture 20-23 | Source specific estimation of wastewater generation: domestic, commercial and industrial sources; Types of sewer pipes in a typical sanitary sewer system; Hydraulic design of sewers; Sewer appurtenances: manholes, junctions and drop inlets/manholes | Handout | CO5 |
| Lecture 24-25 | Sewer Construction: Trenching and excavation; Estimation of overburden load on sewer pipes; Bedding conditions for concrete pipes | Handout | CO5 |
| Lecture 26-27 | Statistical Analysis of Wastewater Quantity and Parameters; Sustained Loading: Definition and examples of sustained loading; Estimation of sustained loadings; Problem solving | Handout | CO5 |
| Lecture 28 | Class test-2 | | |
| Lecture 29-31 | Wastewater characteristics<br>Biochemical and chemical oxygen demand | Handout | CO7 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 32-36 | Treatment of wastewater: Treatment objectives, classification of treatment processes and treatment systems; Preliminary/preparatory treatment; Primary treatment, including design of sedimentation basin/clarifier; Microbiology of sewage; Secondary treatment of wastewater | Handout | CO6<br>CO7 |
| Lecture 37-39 | Treatment and disposal of industrial wastewater | Handout | CO6 |
| Lecture 40-41 | Sludge treatment and disposal | Handout | CO8 |
| Lecture 42 | Class test-3 | | |
| Lecture 43-45 | Introduction to sanitation; Classification of wastes; Linkages between water supply, sanitation and health; Classification of sanitation system | Handout | CO3 |
| Lecture 46-51 | Low-cost onsite sanitation technologies: Hygienic latrine; Technological options for rural and urban low-income communities; Design of pit latrines and pour-flush latrines, including design options for areas of difficult hydro-geologic conditions. | Handout | CO4 |
| Lecture 52 | Class test-4 | | |
| Lecture 53-55 | Design of septic tank system (septic tank and soakage pit); Design of anaerobic baffled reactor (ABR); Introduction to Fecal sludge management (FSM) | Handout | CO3<br>CO4 |
| Lecture 56 | Class test-5 | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least five class tests will be administered. Best four of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of Academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **Wastewater Engineering: Treatment and Resource Recovery** by Metcalf & Eddy, George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, Franklin L. Burton – McGraw Hill (4th and 5th Edition)
2. **Sewerage Design**, Trent McGee – McGraw Hill
3. **Water Supply and Sanitation: Rural and Low Income Urban Communities** by M. Feroze Ahmed and Md. Mujibur Rahman, ITN-Bangladesh (3rd Edition)

**14.** References

1. **Handbook of Water and Wastewater Engineering**, McGraw Hill

## 20.31 Description of Course CE 341

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Principles of Soil Mechanics** |
| **2.** | Type of Course | Geotechnical Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | CE 203 |

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

Introduction to geotechnical engineering; formation, type and identification of soils; soil composition; soil structure and fabric; index properties of soils; engineering classification of soils; soil compaction; principles of total and effective stresses; permeability and seepage; stress-strain-strength characteristics of soils; compressibility and settlement behaviour of soils; lateral earth pressure; stress distribution.

**6.** Course Objectives

- To introduce fundamentals of Geotechnical Engineering
- To introduce different soil strength parameters and corresponding field and laboratory tests.
- To familiarize lateral earth pressure, wight -volume relationship and consolidation theory.

**7.** Knowledge required

Preliminary knowledge of Geology.

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *comprehend* the concept of formation, composition, structure and fabric and index properties of soils | PO(a),PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *characterize, identify* and *classify* different types of soils (visual-manual procedure and engineering classification of soils) | PO(a),PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 3 | *explain* the concept of shear strength of soils and to *evaluate* undrained shear strength and shear strength parameters (undrained and effective) based on laboratory tests (unconfined compression test, direct shear tests and different types of triaxial compression tests) and field test (field vane shear test) | PO(a),PO(b) | C2, C5 | Lectures, Class participation | Class test, final examination |
| 4 | *explain* the concept of lateral earth pressure and to *evaluate* active and lateral earth pressures for designing retaining structures | PO(a),PO(b) | C2, C5 | Lectures, Class participation | Class test, final examination |
| 5 | *explain* weight-volume relationships of soil and to *determine* compaction | PO(a),PO(b) | C2, C5 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | characteristics of soils and their application in geotechnical design and construction | | | | |
| 6 | *estimate* seepage and thereby to evaluate stability of hydraulic structures | PO(a),PO(b) | C5 | Lectures, Class participation | Class test, final examination |
| 7 | *compute* increase in vertical stress distribution below the foundation due to various types of loading. | PO(a),PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 8 | *estimate* the rate and amount of foundation settlement applying the concepts of one-dimensional consolidation theory in geotechnical problems | PO(a),PO(b) | C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-6 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-7 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-8 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1-2 | Introduction to Geotechnical Engineering; Formation and different types of soil deposits | Lecture Materials | CO-1 |
| Lecture 3-4 | Soil particle sizes and types of soil based on soil particle size; description and Identification of Soils (Visual –Manual Procedure). | Lecture Materials | CO-2 |
| Lecture 5 | Primary and secondary structures of soils; Structure and Fabric of coarse-grained soils and clay soils; Shape of coarse-grained soil particle | Lecture Materials | CO-1 |
| Lecture 6-7 | Soil Classification tests and index properties of soils; Grain size analyses by dry sieving, wash sieving and | Lecture Materials | CO-1, CO-2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| | hydrometer; Grain size distribution curves; Definition of uniformity coefficient and Coefficient of curvature and effective diameter of coarse grained soils; Well graded, poorly graded and gap graded sands. | | |
| Lecture 8 | Solution of numerical problems involving grain size analyses of coarse grained soils (sands) Combined analyses (Sieve and Hydrometer) to determine particle size distributions of fine grained soils (clays and silts). | Lecture Materials | CO-1, CO-2 |
| Lecture 9 | Definitions of Atterberg limits (liquid limit, plastic limit, Shrinkage limit); Plasticity index, Linear shrinkage, Flow index, Toughness index, liquidity index, consistency index and Activity of fine- grained soil. | Lecture Materials | CO-1, CO-2 |
| Lecture 10-11 | Experimental determination of liquid limit and plastic limit using Casagrande's apparatus and Cone penetrometer (fall cone) apparatus. One Point method of determining liquid limit. Experimental determination of shrinkage limit; Derivation of expressions for shrinkage limit for known and unknown specific gravity of soil solids ($G_s$). | Lecture Materials | CO-1, CO-2 |
| Lecture 12-13 | Engineering Classification of Soils; Unified Soil Classification System (USCS); Casagrande's Plasticity Chart based on USCS; Group symbols for cohesionless soils (coarse grained) and cohesive soils (fine grained soils) based on Casagrande's Plasticity Chart; Solution of numerical problems involving Unified Soil Classification System (USCS). | Lecture Materials | CO-2 |
| Lecture 14 | Engineering Classification of Soils by AASHTO Soil Classification System; Solution of numerical problems involving AASHTO Soil Classification System. | Lecture Materials | CO-2 |
| Lecture 15-16 | Concept of shear strength of soils, factors affecting shear strength of soils; Shear stress and normal stress on failure plane; Mohr Circles; Mohr-Coulomb Failure Envelope in terms of shear and normal stresses; Mohr-Coulomb Failure Envelope in terms of minor principal stress and major principal stress. | Lecture Materials | CO-3 |
| Lecture 17-18 | Shear strength parameters; Undrained shear strength parameters and effective Shear strength parameters; Consolidated drained Direct Shear test on sands (loose sand and dense sand) and clays (normally consolidated and overconsolidated) ; Merits and demerits of Direct shear test; Concept of peak shear strength and residual strength of clays and sands; critical voids ratio of sand; Computations of effective shear strength parameters (effective cohesion, $c'$ and effective angle of internal friction,$\phi'$) considering peak shear strength and residual shear strength | Lecture Materials | CO-3 |
| Lecture 19 | Unconfined compression test, unconfined compressive strength and undrained shear strength, consistency of clays based on undrained shear strength; Sensitivity and thixotropy. | Lecture Materials | CO-3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 20-21 | Triaxial compression tests, Advantages of triaxial compression test over direct shear test, Unconsolidated undrained (UU), consolidated undrained (CU) and consolidated drained (CD) Triaxial compression tests; Behaviour of saturated sands (loose sand and dense sand) and clays (normally consolidated and overconsolidated) in UU, CU and CD Triaxial compression tests; Examples of UU, CU and CD analyses in clays. | Lecture Materials | CO-3 |
| Lecture 22 | Modified Failure Envelope; Skempton's Pore Pressure Coefficients A and B; Computation of Skempton's Pore Pressure Coefficients A at failure ($A_f$) and B; Empirical relationships between Undrained shear strength ($s_u$) and effective overburden pressure ($\sigma v'$) for normally consolidated and overconsolidated clays. | Lecture Materials | CO-3 |
| Lecture 23-24 | Computation of undrained shear strength parameters (undrained cohesion, $c_u$ and and undrained angle of internal friction, $\phi_u$) and effective shear strength parameters (effective cohesion, $c'$ and effective angle of internal friction, $\phi'$) from triaxial compression tests analytically, by drawing Mohr circles and Mohr-Coulomb Failure Envelope, and Modified Failure Envelope. Field vane shear test on soft clays; Computation of undrained shear strength ($s_u$) of soft clays from field vane shear test. | Lecture Materials | CO-3 |
| Lecture 25 | Concept of at-rest, active and passive pressures; Coefficient of earth pressure at rest ($K_0$); Coefficients of active earth pressure ($K_a$) and passive earth pressure ($K_p$); Rankine's theory of lateral earth pressure; Active and passive earth pressures in cohesionless soil, Derivation of expressions for active earth pressure and passive earth pressure in cohesive ($\phi$=0) and cohesive-frictional (c-$\phi$) soil. | Lecture Materials | CO-4 |
| Lecture 26-27 | Depth of tension crack; Unsupported height of wall; Effect of surcharge pressure on lateral pressure; Computations of active earth pressure distributions; Computations of total active force (thrust) and location of resultant active force (thrust) against retaining wall; Computations of total active force (thrust) before and after development of tension cracks for $\phi$=0 condition. | Lecture Materials | CO-4 |
| Lecture 28 | Rankine active and passive pressure with sloping backfill for cohesionless soil and cohesive-frictional (c-$\phi$) soil; Computations of total active force (thrust) for cohesive-frictional (c-$\phi$) sloping backfill after development of tension cracks; Coulomb's earth pressure theory. | Lecture Materials | CO-4 |
| Lecture 29 | Introduction to Geotechnical Engineering, History of development of Soil Mechanics. | Lecture Materials | CO-1 |
| Lecture 30-32 | Weight-Volume relationships of Soil Aggregate; Solving Example Problems. | Lecture Materials | CO-5 |
| Lecture 33-34 | Density Index and Compactions of Soils. | Lecture Materials | CO-1 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| | | | |
| Lecture 35 | Permeability of soil, Darcy's Principle and its limitations. | Lecture Materials | CO-6 |
| Lecture 36-37 | Factors affecting coefficient of permeability and its determination in the Laboratory, Field Pumping Test. | Lecture Materials | CO-6 |
| Lecture 38-39 | Principle of Effective stress, Seepage Pressure, Quick Condition. | Lecture Materials | CO-6 |
| Lecture 40 | Continuity Equation and its graphical interpretation, Flow Nets construction for confined flow problem. | Lecture Materials | CO-6 |
| Lecture 41-42 | Hydraulic force under a structure and safety of Hydraulic structure against Piping and Filter design to mitigate seepage force. Solving Examples Problems. | Lecture Materials | CO-6 |
| Lecture 43-44 | Concept of 1D-Consolidation. Normally consolidate Clay, Over Consolidate Clay, Causes of over Consolidation and Determination of Pre-Consolidation Pressure Consolidation Test Procedure. | Lecture Materials | CO-8 |
| Lecture 45-47 | Construction of Field e-log(p) curve for NC and OC clays and settlement calculation. Determination of Coefficient of Consolidation, , Coefficient of Compressibility and Coefficient of Volume compressibility, Settlement computation due to Primary Consolidation, Example Problems for settlement computation | Lecture Materials | CO-8 |
| Lecture 48-49 | Derivation of 1D-Consolidation Equation, Determination of time factor ($T_v$), Coefficient of Consolidation ($c_v$), Example problems for rate calculation. | Lecture Materials | CO-8 |
| Lecture 50 | Causes of Secondary Consolidation &Settlement due it. Application of 3D-Consolidation | Lecture Materials | CO-8 |
| Lecture 51-52 | Boussinesq's Theory for Point Loading, Stress due to Line Load of Infinite Length, Stress due to Line Load of Finite Length. | Lecture Materials | CO-7 |
| Lecture 53-54 | Stress due to Strip area Uniform Pressure, Triangular Pressure and Embankment Loading. | Lecture Materials | CO-7 |
| Lecture 55 | Stress due to circular Loading and Rectangular Loading. | Lecture Materials | CO-7 |
| Lecture 56 | Stress due to any arbitrary shape of Loading using Newmark's Influence Chart. | Lecture Materials | CO-7 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least five class tests will be administered. Best four of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

a. Principles of Geotechnical Engineering
Author: B.M. Das.

b. Foundation Engineering;
Authors: Ralph B. Peck, Walter E. Hanson, Thomas H. Thornburn

**14.** References

a. Advanced Soil mechanics
Author: B. M. Das

b. Soil Mechanics and Foundation Engineering
Author: S.K. Garg

c. An Introduction to Geotechnical Engineering
Authors: Robert D. Holtz and William D. Kovacs

d. Soil Mechanics
Author: R. F. Craig

e. Soil Mechanics and Foundation Engineering
Author: V. N. S. Murthy

f. Modern Geotechnical Engineering
Author: Alam Singh

g. Soil Mechanics
Author: M. Pallanikumar

h. Soil Mechanics and Foundations
Author: B. C. Punmia

## 20.32 Description of Course CE 342

### SECTION A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **Geotechnical Engineering Laboratory** |
| **2.** | Type of Course | Geotechnical Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Field identification tests of soils; grain size analysis by sieve and hydrometer; specific gravity test; Atterberg limits test; permeability tests; unconfined compression test; compaction test; relative density test; direct shear tests; consolidation tests; test of geotextiles.

**6.** Course Objectives

- To introduce different experimental methods required for engineering classification, stress-strain-strength characteristics, compressibility behaviour, compaction and flow properties of soils.
- To familiarize with some routine tests (thickness, strip tensile strength, CBR puncture etc.) of geo-synthetic materials.

**7.** Knowledge required

Preliminary knowledge in geotechnical engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *classify* different types of soil through field identification test and laboratory testing. | PO(a), PO(d) | C1, C3 | Lectures, Class participation | Class Assessment, Lab Report, Viva, Quiz. |
| 2 | *determine* strength, permeability, consolidation and other characteristics of soil through experimental investigation. | PO(a), PO(d) | C1, C4 | Lectures, Class participation | Class Assessment, Lab Report, Viva, Quiz. |
| 3 | *Introduce* some routine tests of geo-synthetic materials. | PO(a), PO(d) | C1, C3 | Lectures, Class participation | Class Assessment, Lab Report, Viva, Quiz. |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CO-2 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CO-3 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction And Field Identification Tests of Soils | Handout | CO1 |
| Lecture 2 | Specific Gravity of Soils and Grain Size Distribution | Handout | CO1 |
| Lecture 3 | Grain Size Analysis by Hydrometer | Handout | CO1 |
| Lecture 4 | Atterberg Limits Test | Handout | CO1 |
| Lecture 5 | Maximum-Minimum Density Tests of Sand | | CO2 |
| Lecture 6 | Compaction Test | Handout | CO2 |
| Lecture 7 | Mid Quiz and Viva | | |
| Lecture 8 | Permeability Test | Handout | CO2 |
| Lecture 9 | Unconfined Compression Test | Handout | CO2 |
| Lecture 10 | Direct Shear Test | Handout | CO2 |
| Lecture 11 | Consolidation Test | Handout | CO2 |
| Lecture 12 | Test of Geotextiles | Handout | CO3 |
| Lecture 13 | Final Quiz and Viva | | |
| Lecture 14 | Extra Class If Required | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: Class assessment on almost all experiments will be administered.
- Final Examination: Quizzes and viva will be held at mid and the end of the Term.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Assessment | 20% |
| Lab Report | 20% |
| Viva | 20% |
| Mid Quiz | 15% |
| Final Quiz | 15% |

13. Textbook
    a. Soil Testing for Engineers: T William Lambe
    b. Engineering Properties of Soils and Their Measurements: Joseph E. Bowels
14. References
    a. Foundation Engineering: Peck, Hansen & Thornburn

## 20.33 Description of Course CE 351

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | Transportation Engineering, I: Transportation Planning and Traffic Engineering |
| **2.** | Type of Course | Transportation Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Transportation engineering, transportation functions; transportation systems, functional components, factors in transportation development, transportation modes, public transportation, emerging modes; intelligent transportation system: components and applications; transport planning: concepts, scope and hierarchy, process, goals and objectives, inventories, socio-economic activities, land use-transport interaction, travel demand forecasting; road safety and accident analysis.

Geometric design of highways: design controls and criteria, cross sectional elements, alignment, sight distance, intersection and interchange layouts, planning and design of bicycle and pedestrian facilities; traffic engineering: fundamentals of traffic engineering, vehicle and traffic characteristics, traffic control devices and systems, traffic studies, planning and design of parking facilities, roadway lighting; transportation in Bangladesh: transportation modes and networks, constraints and challenges, transport demand and modal share, road classification and design standards.

**6.** Course Objectives

- To introduce transport system planning, components, function; transportation modes, intelligent transport system, travel demand forecasting; fundamentals of traffic engineering
- To learn to analyse socio-economic, land-use and other traffic survey and crash data
- To learn to evaluate various transportation modes, transport performance, road types and design & safety standards, relevant Bangladesh issues
- To learn to plan and design roadway elements and furniture including NMV and pedestrian facilities using standard design practices

**7.** Knowledge required

Preliminary Knowledge in Civil Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *explain* transport system planning, components, function; transportation modes, intelligent transport system, travel demand forecasting; fundamentals of traffic engineering | PO(a) | C2, C5, C6, A3, A4, P2 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 2 | *analyse* socio-economic, land-use and other traffic survey and crash data | PO(a)<br>PO(f) | C4 | Lectures, Class participation | Class test, final examination |
| 3 | *evaluate* various transportation modes, transport performance, road types and design & safety standards; relevant Bangladesh issues | PO(c) | C4, C5 | Lectures, Class participation | Class test, final examination |
| 4 | *plan* and *design* roadway elements and furniture including NMV and pedestrian facilities using standard design practices | PO(c) | C6, P7 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-2 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-3 | | | | | ✓ | | | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Lecture No. | Topic | Reference | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Transportation Engineering: | Reference Book1 | CO1 |
| Lecture 2 | Transportation functions; functional components | Reference Book2 | CO1 |
| Lecture 3 | Ttransportation system view, study and analysis | Reference Book 3 | CO1 |
| Lecture 4 | Factors in transportation development | Reference Book 4 | CO1 |
| Lecture 5 | Transportation modes, | Handout, book | CO3 |
| Lecture 6 | Emerging transport modes and technologies | Handout, book | CO1 |
| Lecture 7 | Intelligent transportation system, components and applications I | Handout, book | CO1 |
| Lecture 8 | Intelligent transportation system, components and applications-II | Handout, book | CO1 |
| Lecture 9 | Public transportation I | Handout, book | CO3 |

| Lecture No. | Topic | Reference | Corresponding CO(s) |
|---|---|---|---|
| Lecture 10 | Public transportation-II | Handout, book | CO3 |
| Lecture 11 | Public transportation-III | Handout, book | CO3 |
| Lecture 12 | Bangladesh Transportation Modes and networks, | Bangladesh RHD, LGED road database and manual | CO3 |
| Lecture 13 | Bangladesh Transportation Constraints and Challenges, | Transport Sector planning and study report, Ministry of planning, Bangladesh | CO3 |
| Lecture 14 | Bangladesh Transport Demand and Modal share, Roadway Classification and design standards. | Handout, book | CO3 |
| Lecture 15 | Bangladesh Roadway Classification and design standards. | Handout, book | CO3 |
| Lecture 16 | **Transport Planning**: concepts, scope and hierarchy, | Handout, book | CO2 |
| Lecture 17 | **Transport Planning**: process, goals and objectives, | Handout, book | CO2 |
| Lecture 18 | **Transport Planning**: inventories, socioeconomic activities, | Handout, book | CO2 |
| Lecture 19 | **Transport Planning**: land-use interaction, | Handout, book | CO2 |
| Lecture 20 | **Transport Planning**: travel demand forecasting; | Handout, book | CO2 |
| Lecture 21 | **Transport Planning**: travel demand forecasting; | Handout, book | CO2 |
| Lecture 22 | **Transport Planning**: road safety and accident analysis. | Handout, book | CO2 |
| Lecture 23 | **Geometric design of highways**: Design controls and criteria | Handout, book | CO4 |
| Lecture 24 | **Geometric design of highways:** Cross sectional elements | Handout, book | CO4 |
| Lecture 25 | **Geometric design of highways**: alignment, sight distances, | Handout, book | CO4 |
| Lecture 26 | **Geometric design of highways**: intersections and interchanges layouts, | Handout, book | CO4 |
| Lecture 27 | **Geometric design of highways**: Planning and design of bicycle and pedestrian facilities. | Handout, book | CO4 |

| Lecture No. | Topic | Reference | Corresponding CO(s) |
|---|---|---|---|
| Lecture 28 | **Geometric design of highways**: Planning and design of bicycle and pedestrian facilities. | Handout, book | CO4 |
| Lecture 29 | **Traffic engineering**: Fundamentals of Traffic Engineering; | Handout, book | CO4 |
| Lecture 30 | **Traffic engineering**: Fundamentals of Traffic Engineering; | Handout, book | CO4 |
| Lecture 31 | **Traffic engineering**: Vehicle and traffic characteristics, | Handout, book | CO4 |
| Lecture 32 | **Traffic engineering**: Vehicle and traffic characteristics, | Handout, book | CO4 |
| Lecture 33 | **Traffic engineering**: Vehicle and traffic characteristics | Handout, book | CO4 |
| Lecture 34 | **Traffic engineering**: Vehicle and traffic characteristics, | Handout, book | CO4 |
| Lecture 35 | **Traffic engineering**: Traffic control devices and systems, | Handout, book | CO4 |
| Lecture 36 | **Traffic engineering**: Traffic control devices and systems, | Handout, book | CO4 |
| Lecture 37 | **Traffic engineering**: Traffic studies, | Handout, book | CO4 |
| Lecture 38 | **Traffic engineering**: Traffic studies, | Handout, book | CO4 |
| Lecture 39 | **Traffic engineering**: Planning and design of Parking facilities, | Handout, book | CO4 |
| Lecture 40 | **Traffic engineering**: Planning and design of Parking facilities, | Handout, book | CO4 |
| Lecture 41 | **Traffic engineering**: Roadway lighting. | Handout, book | CO4 |
| Lecture 42 | **Traffic engineering**: Roadway lighting. | Handout, book | CO4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Class Lecture Handout

**14.** References

1. Principles of Transportation Engineering, Chakrobarty and Das, PHI Pub
2. Transportation Engineering: An Introduction, by Khisty and Lall
3. Introduction to Transportation Systems, By Joseph sussman, MIT press
4. Principles of Highway Engineering and Traffic Analysis by Fred L.Mannering, Walter P. Kilareski, and Scott S. Washburn
5. Kadiyali, L.R.,"Traffic Engineering and Transport Planning", Second Edition, 1983.
6. Singh, G. C.,"Highway Engineering", Third Edition, 1991.
7. Wright, P.H. and Paquette, R.J.,"Highway Engineering", Fifth Edition, 1993.
8. O'Flaherty, C.A.,"Highways and Traffic", Volume 1, Second Edition, 1983.
9. Matson, M.T. and Hurd, W.F.," Traffic Engineering", McGraw-Hill, 1955.

## 20.34 Description of Course CE 400

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Undergraduate Thesis** |
| **2.** | Type of Course | Basic Engineering Laboratory (Compulsory) |
| **3.** | Offered to | Civil Engineering (L4/T1 – L4/T2) |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Experimental and theoretical investigation of various topics in structural engineering, environmental engineering, transportation engineering and geotechnical engineering. Individual or group study of one or more topics from any of the above fields. The students will be required to present and submit thesis at the end of the work.

**6.** Course Objectives

- Students will be able to apply the basic and specialized engineering knowledge in solving new problems
- Students will learn literature review
- Students will be able to develop research methodology in solving a problem considering available resources and technology
- Students will be able to analyse and interpret data/reports

**7.** Knowledge required

Fundamentals of Civil Engineering, Basic Science

**8.** Course Outcomes

At the end of the course a student should be able to

| **CO No.** | **CO Statement** | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| 1 | *apply* the basic and specialized engineering knowledge in solving engineering problems | PO(b) | C3 | Lectures/Instructions, Project participation | Presentation, Report |
| 2 | *identify* and *summarize* relevant literature | PO(l), PO(h) | C5, A2 | Lectures/Instructions, Project participation | Presentation, Report |
| 3 | *critically evaluate* alternative approaches in solving problems | PO(d) | C5 | Lectures/Instructions, Project participation | Report |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 4 | *develop* research methodology in solving a problem considering available resources and technology | PO(c) | C6 | Lectures/Instructions, Project participation | Presentation, Report |
| 5 | *analyse* and *interpret* data/results generated from the research work and relevant literature | PO(d) | C4, A5 | Lectures/Instructions, Project participation | Presentation, Report |
| 6 | *demonstrate* behaviour consistent with academic integrity expectation | PO(h) | A3 | Lectures/Instructions, Project participation | Presentation, Report |
| 7 | *communicate* knowledge in a scientific manner | PO(j) | C5, A2 | Lectures/Instructions, Project participation | Presentation |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | ✓ | | | | | ✓ | | | | | | | | | ✓ | | ✓ |
| CO-2 | | | | | | | ✓ | | | | | | | | | | | ✓ | | |
| CO-3 | | | | | | | | ✓ | ✓ | | ✓ | | | | | ✓ | | | | ✓ |
| CO-4 | | | | | ✓ | | | | | | ✓ | ✓ | | | | ✓ | | | | |
| CO-5 | | | | | | | | ✓ | ✓ | | | | | | | | | ✓ | | |
| CO-6 | | | | | | | ✓ | | | | | | | | | ✓ | | | | |
| CO-7 | | | | | | | | | | | | | | | | | | ✓ | | |

**10.** Lecture Plan

Not Applicable

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Presentation: A brief ppt presentation will be held on relevant topics
- Dissertation Writing: A brief report on the research topic

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Application of basic engineering knowledge | 10% |
| Literature review | 10% |
| Rationale and objective | 10% |
| Methodology | 20% |
| Analysis and discussion | 20% |
| Presentation and writing | 20% |
| Academic integrity, references | 10% |
| Total | 100% |

**13.** Textbook

Not Applicable

**14.** References

Not Applicable

## 20.35 Description of Course CE 401

### SECTION A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **Project Planning and Construction Management** |
| **2.** | Type of Course | Basic Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Project evaluation: cash flow and net present value, perpetuities and annuities, internal rate of return, payback period, benefit-cost ratio, real and nominal interest rate, capital budgeting, risk versus return, capital asset pricing model and project cost of capital, financial and economic feasibility, sensitivity analysis.**

**Leading and managing teams: human resource management, dysfunctions in teams, team development, conflict management, leading teams, self-managing teams, decision making in teams, case study.**

**Project operation management: project as a process, inventory management, economic order quantity, demand forecasting –newsvendor model, labour and plant management – line balancing, legal and ethical issues in project – case study, environmental regulations, procurement – value for money (VfM).**

**Project planning and control: planning and scheduling, PERT, CPM, resource scheduling, linear programming and application.**

**Construction management: principles, project organization, methods and practices, technology, management of materials and equipment, site management, contracts and specifications, inspection and quality control, quality assurance, safety, economy**

**6.** Course Objectives

- To introduce various feasibility tools to evaluate engineering projects
- To acquire knowledge regarding construction management.
- To acquire knowledge for assessing feasibility reports.
- To acquire knowledge on ethical issues of project management.

**7.** Knowledge required: Preliminary knowledge in Civil Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *assess* financial and economic feasibility report using various techniques for a project | PO(k) | C5 | Lectures, Class participation | Class test, final examination |
| 2 | *differentiate* various knowledge area of project management based on established book of knowledge | PO(k) | C4 | Lectures, Class participation | Class test, final examination |
| 3 | *prepare* a project plan and relevant documentation | PO(k) | C3 | Lectures, Class participation | Class test, final examination |
| 4 | *schedule* a project using network planning techniques with relevant software tools | PO(c) | C3 | Lectures, Class participation | Class test, final examination |
| 5 | *formulate* a linear programming model for resource allocation and optimization and *solve* the model using simplex method | PO(k) | C6 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | using appropriate software and programming tools | | | | |
| 6 | *describe* legal, ethical and environmental issues of project management | PO(g) | C2 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | √ | | | | | | | | | | | | | | | | |
| CO-2 | | | | √ | | | | | | | | | | | | | | | | |
| CO-3 | | | | √ | | | | | | | | | | | | | | | | |
| CO-4 | | | | | √ | | | | | | | | | | | | | | | |
| CO-5 | | | | | | √ | | | | | | | | | | | | | | |
| CO-6 | | | | | | | √ | | | | | | | | | | | | | |

10. Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to Project and Project management | Handout | CO1 |
| Lecture 2 | Project Organization | Handout, Masters | CO1 |
| Lecture 3 | Project Life Cycle | Handout, Masters | CO1 |
| Lecture 4 | Class Test 1 | | CO1 |
| Lecture 5-6 | Project Time Management | Handout, Masters | CO2 |
| Lecture 7-8 | Project Cost Management | Handout, Masters | CO2 |
| Lecture 9-10 | Project Safety Management, Safety Precautions required in Construction industry | Handout, Masters | CO2 |
| Lecture 11-12 | Project Quality Management | Handout, Masters | CO2 |
| Lecture 13 | Construction Equipment | Handout, Masters | CO2 |
| Lecture 14 | Review, Class test 2 | | CO2 |
| Lecture 15 | The Project Planning Process | Handout | CO3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 16 | Components of a Project Plan | Handout, Masters | CO3 |
| Lecture 17 | Work Breakdown Structure (WBS) | Handout, Masters | CO3 |
| Lecture 18 | Scheduling of Projects | Handout, Masters | CO4 |
| Lecture 19 | Network Planning Techniques | Handout, Masters | CO4 |
| Lecture 20 | The Critical Path Method (CPM) | Handout, Masters | CO4 |
| Lecture 21 | Project Evaluation and Review Technique (PERT) | Handout, Masters | CO4 |
| Lecture 22 | Reducing Project Completion Time: Project Crashing | Handout, Masters | CO4 |
| Lecture 23 | Resource Analysis and Scheduling | Handout, Masters | CO4 |
| Lecture 24 | Standard Linear Programming (LP) Problems and their Characteristics | Handout, Masters | CO5 |
| Lecture 25 | Formulation of Linear Programming Problems | Handout, Masters | CO5 |
| Lecture 26 | Solution of Standard Linear Programming Problems | Handout, Masters | CO5 |
| Lecture 27 | Review | | CO5 |
| Lecture 28 | Class Test | | CO5 |
| Lecture 29 | Introduction | Handout | CO2 |
| Lecture 30 | Role of Human Resource Management | Handout, Masters | CO2 |
| Lecture 31 | Team and Team development | Handout, Masters | CO2 |
| Lecture 32 | Team Conflict | Handout, Masters | CO2 |
| Lecture 33 | Leadership and Building Team Performance | Handout, Masters | CO2 |
| Lecture 34 | Effective Decision Making in Teams | Handout, Masters | CO2 |
| Lecture 35 | Simulation on Decision Making in Teams | Handout, Masters | CO2 |
| Lecture 36 | Inventory Management and Economic Order Quantity (EOQ) | Handout, Masters | CO2 |
| Lecture 37 | Newsvendor Model for Optimal Inventory Forecasting | Handout, Masters | CO2 |
| Lecture 38 | Line Balancing for Labour and Plant Management | Handout, Masters | CO2 |
| Lecture 39 | Legal & Ethical Issues in Construction Management | Handout, Masters | CO6 |
| Lecture 40 | Procurement and Value for Money | Handout, Masters | CO2 |
| Lecture 41 | Environmental Regulations | Handout, Masters | CO2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 42 | Class Test 1 | | CO2<br>CO6 |
| Lecture 43 | Time Value of Money | Handout, Masters | CO2 |
| Lecture 44 | Annuity and Perpetuity | Handout, Masters | CO2 |
| Lecture 45 | NPV and IRR | Handout, Masters | CO2 |
| Lecture 46 | BCR, Payback Period and Annual equivalent annuities | Handout, Masters | CO2 |
| Lecture 47 | Project Discount Rate | Handout, Masters | CO2 |
| Lecture 48 | Weighted Average Cost of Capital | Handout, Masters | CO2 |
| Lecture 49 | Class Test 2 | | CO2 |
| Lecture 50 | Financial Feasibility Analysis | Handout, Masters | CO2 |
| Lecture 51 | Case study on Financial Feasibility of Project | Handout, Masters | CO2 |
| Lecture 52 | Economic Feasibility Analysis | Handout, Masters | CO2 |
| Lecture 53 | Case study on Economic Feasibility of Project | Handout, Masters | CO2 |
| Lecture 54 | Class Test 3 | | CO2 |
| Lecture 55 | Feasibility Study Report and Development Project Proposal (DPP) | Handout, Masters | CO2 |
| Lecture 56 | Conclusion | | CO2 |

11. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least five class tests will be administered. Best four of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

12. Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

13. Textbook

1. Project Management, 3rd Ed, A Systems Approach to Planning, Scheduling and Controlling, Harold Kenzier
2. Project Management, A Managerial Approach, 4th Ed, Jack R. Meredith, Samuel J. Mantel, Jr.

3. PMBOK Guide
4. Katzenbach, J. R., & Smith, D. K. (2008). The discipline of teams. Harvard Business Press.
5. Druskat, V. U., & Wheeler, J. V. (2004). How to lead a self-managing team. MIT Sloan Management Review, 45(4), 65.
6. Gilley, J. W., Morris, M. L., Waite, A. M., Coates, T., & Veliquette, A. (2010). Integrated theoretical model for building effective teams. Advances in Developing Human Resources, 12(1), 7-28.
7. Jehn, K. A., & Bendersky, C. (2003). Intragroup conflict in organizations: A contingency perspective on the conflict-outcome relationship. Research in organizational behavior, 25, 187-242.
8. Goleman, D. (2000). Leadership that gets results. Harvard business review, 78(2), 4-17
9. Cachon, G., & Terwiesch, C. (2008). Matching supply with demand. McGraw-Hill Publishing.
10. Asian Development Bank. (1999). Handbook for the Economic Analysis of Water Supply Projects
11. Asian Development Bank. (1997). Guidelines for the economic analysis of projects.
12. Campbell, H. F., & Brown, R. P. (2003). Benefit-cost analysis: financial and economic appraisal using spreadsheets. Cambridge University Press
13. Andrews, G.C and Kemper, J.D. Canadian Professional Engineering Practice and Ethics.
14. Sales, H.E., Professional communication in Engineering.
15. Leo Finkelstein, Jr., Pocket book of technical writing for Engineers and Scientist.

14. References: N/A

## 20.36 Description of Course CE 403

**SECTION A: General Information**

| | | |
|---|---|---|
| 1. | Course Title | **Sustainability of Development Projects** |
| 2. | Type of Course | Basic Engineering |
| 3. | Offered to | Civil Engineering |
| 4. | Pre-requisite Course(s) | None |

**SECTION B: Course Details**

5. Course Content (As approved by the Academic Council)

   **Environment and sustainable development; sustainable development goals (SDGs); economics and social structure; development and economic growth; socio-economic indicators; concept of human development, human development index; gender related human development index; human poverty and human poverty index; poverty reduction strategies in Bangladesh.**
   **Socio-economic aspects of development projects; human interest related aspects; land loss, land use and land ownership patterns; population displacement; resettlement and rehabilitation strategy; inequalities in distribution of benefits and losses.**
   **Socio-economic impact assessment approach; socio-economic survey; case studies.**

6. Course Objectives
   - identify the various socio-economic impacts of development projects.
   - prepare outlines of Social Impact Assessment (SIA) of various development projects with specific focus on land acquisition and resettlement related action plans
   - lean the importance and means of local community participation, Client Cantered Approach, and locally available resources in design, planning, and implementing a development project
   - integrate SDGs goals, targets, indicators, various socio-economic Development Indicators to evaluate the outcomes of a development project

7. Knowledge required: Basic engineering and social science

8. Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *identify* the various socio-economic impacts of development projects; specifically *identify* the land acquisition and resettlement related key issues for large scale development projects emphasizing the Bangladesh context | PO(f) | C4, C4, A4, A5 | Lectures, Class participation | Class test, term project, assignment, final examination |
| 2 | *prepare* outlines of Social Impact Assessment (SIA) of various development projects with specific focus on land acquisition and resettlement related impacts | PO(f), PO(g), PO(j) | C4, C6 A4, A5 | Lectures, Class participation | Class test, term project, assignment, final examination |
| 3 | *lean* the importance and means of local community participation and locally available resources in development projects | PO(f), PO(g) | C2, A2 | Lectures, Class participation | Class test, term project, assignment, final examination |
| 4 | *integrate* tools for incorporating Client Cantered Approach for design, planning, and implementing development projects | PO(f), PO(g) | C4, C6, A4 | Lectures, Class participation | Class test, assignment, final examination |
| 5 | *integrate* SDGs goals, targets, indicators, various socio-economic Development Indicators to *evaluate* the outcomes of various development projects | PO(f), PO(g) | C3, C5, A5 | Lectures, Class participation | Class test, assignment, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | √ | | | | | | | | | | | | | |
| CO-2 | | | | | | | √ | | | | | | | | | | | | | |
| CO-3 | | | | | | | √ | | | | | | | | | | | | | |
| CO-4 | | | | | | | √ | | | | | | | | | | | | | |
| CO-5 | | | | | | | √ | | | | | | | | | | | | | |

10. Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Class 1 | Introduction to development projects and sustainability | Handout | CO-1, CO-2 |
| Class 2 | Introduction to development projects and related Socio-economic issues | Handout | CO-1, CO-2 |
| Class 3 | Introduction to socio-economic impact assessment | Handout | CO-2 |
| Class 4 | Outlines of socio-economic impact assessment study for a development project | Handout | CO-2 |
| Class 5 | Overview of legislations and policies for land acquisition and resettlement for a development project | Handout | CO-2 |
| Class 6 | Overview of legislations and policies for land acquisition and resettlement for a development project | Handout | CO-2 |
| Class 7 | Socio-economic data collection methods for a SIA study | Handout | CO-2 |
| Class 8 | Analysis of Socio-economic data | Handout | CO-2 |
| Class 9 | Identification of Socio-economic impacts of a development project for a SIA study | Handout | CO-1, CO-2 |
| Class 10 | Identification of impacts of land acquisition | Handout | CO-1, CO-2 |
| Class 11 | Class Test-1 | - | - |
| Class 12 | Identification of mitigation measures for land acquisition and resettlement related impact | Handout | CO-2, CO-3 |
| Class 13 | management, and monitoring framework for mitigation measures | Handout | CO-2, CO-3 |
| Class 14 | Institutional arrangement for implementing land acquisition and resettlement related action plan | Handout | CO-2, CO-3 |
| Class 15 | grievance redress mechanism for implementing land acquisition and resettlement related action plan | Handout | CO-2, CO-3 |
| Class 16 | Social structure, economics, development, and economic growth | Handout | CO-2, CO-3 |
| Class 17 | Traditional concept of development | Handout | CO-5 |
| Class 18 | Traditional indicators of development | Handout | CO-5 |
| Class 19 | Concept of Sustainable Development | Handout | CO-5 |
| Class 20 | Class Test-2 | - | - |
| Class 21 | Introduction to Sustainable Development Goals (SDGs) | Handout | CO-5 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Class 22 | SDGs: Goals | Handout | CO-5 |
| Class 23 | SDGs: Targets and Indicators | Handout | CO-5 |
| Class 24 | SDGs: Targets and Indicators | Handout | CO-5 |
| Class 25 | Linking SDGs goals and targets and outcomes of development projects | Handout | CO-5 |
| Class 26 | Linking SDGs goals and targets and outcomes of development projects | Handout | CO-5 |
| Class 27 | Development Indices | Handout | CO-5 |
| Class 28 | Development Indices | Handout | CO-5 |
| Class 29 | Class Test-3 | - | - |
| Class 30 | Introduction to Client Cantered Approach | Handout | CO-3, CO-4 |
| Class 31 | Application of Client Cantered Approach for design, planning and implementing development projects | Handout | CO-3, CO-4 |
| Class 32 | Application of Client Cantered Approach for design, planning and implementing development projects | Handout | CO-3, CO-4 |
| Class 33 | Land-use and land ownership patterns in Bangladesh | Handout | CO-1, CO-2, CO-3 |
| Class 34 | land loss, land-use and land ownership patterns from implementing development projects | Handout | CO-1, CO-2, CO-3 |
| Class 35 | land loss, land use and land ownership patterns from implementing development projects | Handout | CO-1, CO-2, CO-3 |
| Class 36 | inequalities in distribution of benefits and losses of development projects | Handout | CO-1, CO-3, CO-4 |
| Class 37 | inequalities in distribution of benefits and losses of development projects | Handout | CO-1, CO-3, CO-4 |
| Class 38 | Poverty reduction strategies in Bangladesh | Handout | CO-1, CO-5 |
| Class 39 | Poverty reduction strategies and plan, and design for development projects | Handout | CO-1, CO-5 |
| Class 40 | Poverty reduction strategies and plan, and design for development projects | Handout | CO-1, CO-5 |
| Class 41 | Class Test-4 | - | - |
| Class 42 | Review Class/Discussion on Final Exam Preparation | - | - |

11. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading. Term project/Assignment can be considered as equivalent to class test.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

12. Distribution of Marks

| Item | Marks |
|---|---|
| Attendance/ Class participation | 10% |
| Class Tests/Term Project | 20% |
| Final Examination | 70% |

13. Textbook: N/A
14. References: N/A

## 20.37 Description of Course CE 404

### SECTION A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **Capstone Project CE 404** |
| **2.** | Type of Course | Basic Engineering Laboratory (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Planning, analysis and design of an integrated civil engineering project with emphasis on structural engineering/ environmental engineering/ transportation engineering/ geotechnical engineering specialization. Students shall work in teams to apply civil engineering theories, methodologies, and skills to assess the technical, environmental, and social feasibility of the project including design and cost estimation. Student shall engage their diverse civil engineering and cross disciplinary knowledge to prepare plans and specifications of the project including Bill of Quantity (BoQ) and tender documents.
Students shall present their projects and submit project reports at the end of the work.

**6.** Course Objectives

- To teach students how to apply modern engineering tools and techniques
- To make students realize how teamwork and collaboration works in a project
- To test the ability to find best solutions from alternative approaches
- To evaluate the ability to integrate previous knowledge and experience

**7.** Knowledge required

1. Fundamentals of Civil Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *apply* the techniques, skills and modern engineering tools necessary for engineering practice | PO(e) | C3 | Lectures/Instructions, Project participation | Presentation, Reports |
| 2 | *demonstrate* teamwork ability to work collaboratively with fellow team members and end users | PO(i) | C3 | Lectures/Instructions, Project participation | Presentation, Reports |
| 3 | *evaluate* alternative approaches to identify best solutions considering economic, | PO(f), PO(g) | C6 | Lectures/Instructions, Project participation | Presentation, Reports |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | environmental, social, ethical, health and safety, constructability, and sustainability aspects | | | | |
| 4 | *comprehend* and *demonstrate* professional and ethical responsibility | PO(h) | C3 | Lectures/Instructions, Project participation | Presentation, Reports |
| 5 | *integrate* previous knowledge and experience to enhance life-long learning abilities for their future personal and professional pursuits | PO(l) | C5 | Lectures/Instructions, Project participation | Presentation, Reports |
| 6 | *apply* knowledge for effective project management to ensure efficient use of time, financial resources, and other materials resources. | PO(k) | C3 | Lectures/Instructions, Project participation | Presentation, Reports |
| 7 | *communicate* the design and outcomes of the project in educational and professional settings | PO(j) | C5 | Lectures/Instructions, Project participation | Presentation, Reports |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | ✓ | | | ✓ | ✓ | | | | | ✓ | ✓ | | ✓ | | |
| CO-2 | | | | | | | ✓ | | | | | | | | | | ✓ | | | |
| CO-3 | | | | | | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | ✓ | | |
| CO-4 | | | | | | | ✓ | | | | | ✓ | | | | | | | | |
| CO-5 | | | | | | | | | ✓ | | | | | ✓ | | | | | ✓ | |
| CO-6 | | | | | | | | | ✓ | ✓ | | ✓ | | | | | ✓ | | ✓ | |
| CO-7 | | | | | | | | | | | | | | | | | | | | |

**10.** List of Deliverables

| No. | Deliverable | Timeline | Format |
|---|---|---|---|
| **Level-4/Term-1** | | | |
| 1 | Project Proposal | Week 3 | Writeup and Presentation |
| 2 | Detail planning, methodology, data/survey requirement, stakeholder identification, and identification of external expert requirement | Week 5 | Writeup |
| 3 | Data/survey Summary | Week 8 | Writeup |
| 4 | Preliminary Analysis and Design | Week 11 | Writeup |

| No. | Deliverable | Timeline | Format |
|---|---|---|---|
| 5 | Analysis of Alternatives and preliminary cost estimation | Week 12 | Writeup and Presentation |
| 6 | Feasibility Study (Technical, Social, Environmental, Economic and Financial) | Week 13/Week 14 | Writeup and Presentation |
| **Level-4/Term-2** | | | |
| 7 | Analysis scheme for detail design | Week 1 | Writeup |
| 8 | Analysis output | Week 3 | Writeup and Presentation |
| 9 | Detail Design Report | Week 8 | Writeup, Drawings, and Presentation |
| 10 | Final BoQ, and Cost Estimation | Week 10 | Writeup, and Presentation |
| 11 | Tender Document, Implementation Schedule | Week 12 | Writeup |
| 12 | Final Report | Week 13/14 | Writeup and Drawings |
| 13 | Final Presentation | Week 13/14 | Presentation |
| | | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Presentation: A brief ppt presentation will be held on relevant topics
- Report: A brief report on the project & its outcome

**12.** Distribution of Marks [Rubric for evaluation]

| CO | Description | Criteria | Weightage |
|---|---|---|---|
| CO1 | Application of modern engineering tools | Applied tools for design, drawings, etc. | 10% |
| CO2 | Work on a Team | | 10% |
| CO3 | Alternative analysis presented | Environmental Aspects, health and safety considered | 10% |
| | | Social and ethical obligation considered | 10% |
| CO4 | Professional and ethical responsibility | | 10% |
| CO5 | Lifelong learning | Apply knowledge and demonstrate the ability to learn new skills | 10% |
| CO6 | effective project management – time, financial | Prepared Tender Document | 5% |
| | | Prepared BoQ | 5% |
| | | Show Financial Assessment | 5% |
| | | Show time management skill | 5% |

| CO | Description | Criteria | Weightage |
|---|---|---|---|
| CO7 | Communication | Drawing | 5% |
| | | Presentation | 5% |
| | | Report | 10% |
| **Sum** | | | 100% |

**13.** Textbook

Not applicable

**14.** References

Not applicable

## 20.38 Description of Course CE 405

**SECTION A: General Information**

**1.** Course Title — **Business and Career Development**

**2.** Type of Course — Basic Engineering (Optional)

**3.** Offered to — Civil Engineering

**4.** Pre-requisite Course(s) — None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Understanding and managing organizations: structural, human resource, political, symbolic fames.**
**Developing strategy and competitive advantage: industry analysis, complementor, understanding value, strategy development.**
**Managing disruptive innovations - understanding innovation, organizing for innovation.**
**Marketing management: capturing market insight, connecting with customers, communicating value, building strong brands.**
**Career development: definition of career, value of career development, external and internal dimensions of career, career stages, preparing for job search, networking, interview, career fairs, internship, building online brand, preparing resume, civil engineering careers of the future and vision for civil engineering.**
**Becoming an entrepreneur: identify opportunity, developing business model, designing value Proposition, Lean Start-ups, Hypothesis Testing, Sales & Marketing**

**6.** Course Objectives

- To introduce the business strategy
- To familiarise with the marketing management
- To introduce different aspects related to career development

**7.** Knowledge required: Basic knowledge in Civil Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *dissect* organizations using multiple frames and develop | PO(k) | C4, C6 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | strategies to utilize competitive advantage | | | | |
| 2 | *identify* the sources of innovation and display the attributes of a successful entrepreneur | PO(l) | C4, A5 | Lectures, Class participation | Class test, final examination |
| 3 | *practice* techniques of effective communication and professional conduct in a professional setting | PO(j) | A4 | Lectures, Class participation | Class test, final examination |
| 4 | *apply* the concepts of market management | PO(k) | C3 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | √ | | | | | | | | | | | | | | | | | | | |
| CO-2 | √ | | | | | | | | | | | | | | | | | | | |
| CO-3 | √ | | | | | | | | | | | | | | | | | | | |
| CO-4 | √ | | | | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Career Definition | Handout | CO1 |
| Lecture 2 | Career for civil engineers | Handout | CO1 |
| Lecture 3 | Preparing for job search | Handout | CO3 |
| Lecture 4 | The job search | Handout | CO3 |
| Lecture 5 | Class Test 1 | | |
| Lecture 6 | Internship | Handout | CO3 |
| Lecture 7 | Resumes | Handout | CO3 |
| Lecture 8 | Career Fair | Handout | CO3 |
| Lecture 9 | Interviews | Handout | CO3 |
| Lecture 10 | Class Test 3 | | |
| Lecture 11 | World Economic Forum – Future of Job | Handout | CO2, CO3 |
| Lecture 12 | Civil Engineering Body of Knowledge for the 21st Century | Handout | CO2, CO3 |
| Lecture 13 | Career Development Guide | Handout | CO2, CO3 |
| Lecture 14 | Cover Letters | Handout | CO3 |
| Lecture 15 | Introduction | Handout | CO1 |
| Lecture 16-18 | Organisation | Handout | CO1 |
| Lecture 19 | Class Test 2 | | |
| Lecture 20-21 | Strategy | Handout | CO1, CO2 |
| Lecture 22-23 | Disruption | Handout | CO2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 24 | Class Test 4 | | |
| Lecture 25-26 | Marketing | Handout | CO4 |
| Lecture 27-28 | Entrepreneurship | Handout | CO2 |

**11.** Assessment Strategy
- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook
- Career Development and Planning- A Comprehensive Approach, Second Edition, Authors: Robert C. Reardon, Janet G. Lenz, James P. Sampson, and Gary W. Peterson.
- Engineering Ethics – Concepts and Cases, Charles E. Harris, Michael S. Pritchard, Michael J. Rabins
- Effective Business Communications, Herta A. Murphy, Herbert W. Hildebrandt, Jane P. Thomas
- Career Planning, Dave Ellis, ED Stupka, Doug Toft

**14.** References
- Professional Communication in Engineering, H.E. Sales
- Personal Human Resources Management, David A. DeCenzo, Stephen P. Robbins
- Pocket Book of Technical Writing for Engineers and Scientists, Leo Finkelstein
- Canadian Professional: Engineering Practice and Ethics, Gordon C. Andrews, John D. Kemper
- Career Counseling and Development in a Global Economy, Patrica Anderson, Michael Vandehey

## 20.39 Description of Course CE 410

### SECTION A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **Building Design Sessional** |
| **2.** | Type of Course | Structural Engineering |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Analysis and design of low-rise RC moment frame buildings for wind and low seismic application; multi-storied RC buildings with shear wall and mat foundation for wind and high seismic application; reinforcement design and detailing at joints.**

**6.** Course Objectives
- To enable student to design of low-rise RC moment frame buildings for wind and low seismic load
- To enable student to design multi-storied RC buildings with shear wall and mat foundation for wind and high seismic application.
- To familiarize with reinforcement design and detailing at joints.

**7.** Knowledge required

Preliminary knowledge in concrete structures

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *identify* the structural systems of RC buildings. | PO (a) | C1 | Lectures, Class participation | Class test, final examination |
| 2 | *define* the applicable structural systems and load cases. | PO (a) | C1 | Lectures, Class participation | Class test, final examination |
| 3 | *analyse* the components of RC buildings. | PO (b) | C4 | Lectures, Class participation | Class test, final examination |
| 4 | *design* the components of RC buildings. | PO (c) | C6 | Lectures, Class participation | Class test, final examination |
| 5 | *compare* the designed components with software results. | PO (e) | C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |
| CO-2 | | | | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| CO-5 | | | | | | ✓ | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to the features of a six (6) storied RC framed building, Building geometry and loads, Preliminary size determination of overhead and underground water tanks, determination load for overhead water tank, Preliminary estimation of beam and column sizes based on gravity loads | Handout | CO1 |
| Lecture 2 | Slab design of a typical floor; Analysis, design calculation, and detailing of slab | Handout | CO1, CO3, CO4 |

| | | | |
|---|---|---|---|
| Lecture 3 | Determination of UDL on beams due to dead and live load using the contributory area method [Write individually $W_{DL}$; $W_{LL}$ on beam], Wind and earthquake load calculation, FE model development in ETABS using frame elements only, Application of gravity and lateral nodal loads, Applying supports and boundary conditions, FE Analysis of the model for gravity and lateral loads | Handout | CO1, CO2, CO5 |
| Lecture 4 | Determination of axial force, shear force, and moments due to gravity and lateral loads (individual load case) for selected frames, Verification of gravity and lateral loads against manual calculation, Load combination (SDC C), Deflection and serviceability limits check | Handout | CO1, CO2 |
| Lecture 5 | Design of beam and column, Design of footings | Handout | CO2, CO4 |
| Lecture 6 | Mid Quiz and Viva | | |
| Lecture 7 | UGWT and OHWT | Handout | CO1, CO4 |
| Lecture 8 | IMRFS<br>-slab model<br>-EQ and Wind model automatic<br>-Stiffness modifier and automatic load combination<br>- Serviceability check (Torsional irregularity) | Handout | CO1, CO2, CO3 |
| Lecture 9 | SDC C design.<br>- beam, column design | Handout | CO4, CO5 |
| Lecture 10 | Shear wall for IMRF buildings | Handout | CO1, CO2 |
| Lecture 11 | SDC D | Handout | CO1, CO2, CO3 |
| Lecture 12 | Slab and Mat foundation design. | Handout | CO4, CO5 |
| Lecture 13 | Final Quiz and Viva | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Assessment and Report | 50% |
| Quiz and Viva | 40% |

**13.** Textbook

1. Design of concrete structures – Aurthur H. Nilson, David Darwin, Charles W. Dolan
2. Structural concrete – theory and design – Hassoun, Al-Manaseer

**14.** References

1. 1. Lecture Notes on CE 410.
2. 2. BNBC 2020.

## 20.40 Description of Course CE 411

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **CE411: Analysis of Indeterminate Structures, 3.00 Cr.hr.** |
| **2.** | Type of Course | Structural Engineering |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | CE 311 |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Stiffness properties of beam elements; Moment distribution and flexibility/consistent deformation approaches in solving statically indeterminate structures e.g., beams, frames and trusses; matrix stiffness method in analysing statically indeterminate beams, plane frames, grids and trusses subject to loads, temperature changes, support settlements etc.; computer application oriented direct stiffness method; influence lines of statically indeterminate structures.

**6.** Course Objectives

- To introduce different methods to solve the problems associated with indeterminate structures
- To enable student to draw influence lines of statically indeterminate structures
- To solve the problems related to the temperature changes, support settlements in statically indeterminate structures

**7.** Knowledge required

Basic knowledge in structural analysis, engineering and solid mechanics.

**8.** Course Outcomes

At the end of the course a student should be able to

| **CO No.** | **CO Statement** | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| 1 | *Define* and *comprehend* the stiffness and flexibility parameters of prismatic beam and truss elements, fixed end moments for beam elements. | PO(a)<br>PO(b) | C2 | Lectures, Class participation | final examination |
| 2 | *Apply* principles of moment distribution method to *analyze* statically indeterminate beams and plane frames subject to various kinds of loadings and support movements. | PO(a)<br>PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 3 | *Apply* principles of matrix flexibility method to *analyze* statically indeterminate plane frames and trusses subject to various kinds of loadings. | PO(a)<br>PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 4 | *Apply* principles of matrix stiffness method to *analyze* statically indeterminate beams, plane frames, plane grids and trusses subject to various kinds of loadings and support movements. | PO(a)<br>PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 5 | *Comprehend* and *apply* principles of direct stiffness method to *build* the element stiffness matrix and *construct* the global stiffnes matrix and to *analyze* | PO(a)<br>PO(b) | C4 | Lectures, Class participation | final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | beams, frames and trusses subject to loads and support movements. | | | | |
| 6 | *determine* and draw qualitative and quantitative influence line diagrams of statically indeterminate beams and frames. | PO(a)<br>PO(b) | C4 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | | | | | | | | | | | | | | | | | | |
| CO-2 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-6 | | | | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to properties and features of statically indeterminate structures. Determination of stability and degree of indeterminacy of beams, frames and trusses | Handout | CO1 |
| Lecture 2-3 | Introduction to stiffness characteristics of prismatic beam element, derivation of stiffness parameters of prismatic beam element for end rotation and displacement, fixed end moments of beam elements. | Handout | CO1 |
| Lecture 4 | Relation between stiffness properties and nodal deformation of beam/frame elements. | Handout | CO4 |
| Lecture 5 | Introduction to degrees of freedoms of beams and plane frames. | Handout | CO4 |
| Lecture 6-7 | Analysis of multi-span continuous beams using stiffness method and drawing shear and moment diagrams and qualitative deflected shapes | Handout | CO4 |
| Lecture 8-10 | Analysis of plane non-sway and sway frames using stiffness method. | Handout | CO4 |
| Lecture 11 | Class Test (stiffness method). | | CO4 |
| Lecture 12 | Analysis of beams/frames with support settlement (stiffness method). | Handout | CO4 |
| Lecture 13-14 | Analysis of plane grids using stiffness method. | Handout | CO4 |
| Lecture 15-16 | Formulation of stiffness matrix of a plane truss element; Analysis of plane trusses using stiffness method. | Handout | CO4 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 17 | Formalization of stiffness method of structural analysis | Handout | CO5 |
| Lecture 18-19 | Development and application of direct stiffness method in solving beams and trusses | Handout | CO5 |
| Lecture 20 | Principle of Superposition and Idealization of structure; Introduction to Force Method of Analysis of indeterminate structures (Method of Consistent Deformation, Matrix Flexibility Method). | Handout | CO3 |
| Lecture 21-23 | Comparison between internal and external release systems in beam problems; Analysis of prismatic indeterminate beams in Flexibility Method. | Handout | CO3 |
| Lecture 24 | Class Test (Flexibility Method). | | CO3 |
| Lecture 25 | Analysis of plane frames in Flexibility Method | Handout | CO3 |
| Lecture 27 | Analysis of indeterminate truss in Flexibility Method | Handout | CO3 |
| Lecture 28 | Concept of moment distribution at a joint; Applicability of moment-distribution method for solving indeterminate beams and frames; understanding distribution factor and carry over factors. | Handout | CO2 |
| Lecture 29-30 | Analysis of statically indeterminate beams using moment-distribution method and drawing shear force and bending moment diagrams. | Handout | CO2 |
| Lecture 31 | Analysis of statically indeterminate non-sway frames using moment-distribution method and drawing shear force and bending moment diagrams. | Handout | CO2 |
| Lecture 32 | Class Test (moment distribution method) | | CO2 |
| Lecture 33-34 | Analysis of statically indeterminate sway frames using moment-distribution method | Handout | CO2 |
| Lecture 35 | Introduction to influence lines of indeterminate beams, frames and trusses, Muller-Breslau principle of drawings influence lines. | | CO6 |
| Lecture 36-37 | Qualitative influence lines for beam and frames using Muller-Breslau principle. | Handout | CO6 |
| Lecture 38 | Class Test (influence lines) | | CO6 |
| Lecture 39-41 | Quantitative determination of influence lines of beams. | Handout | CO6 |
| Lecture 42 | General concluding discussion. | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbooks

1. **Structural Analysis,** R. C. Hibbeler, 8th edition, Prentice Hall, New York, USA, 2010.
2. **Structural Analysis,** Aslam Kassimali, 4th edition, Cengage Learning, Stamford, USA, 2012.

**14.** References

1. **Elementary Structural Analysis,** C H Norris, J B Wilbur, and S Utku, 3rd Edition, McGraw-Hill Book Co, Singapore, 1977.
2. **Elements of Structural Analysis,** N C Sinha, New Central Book Agency, New Delhi, India, 2011
3. **Advanced Methods of Structural Analysis,** I A Karnovsky and O Lebed, Springer New York, 2010

## 20.41 Description of Course CE 413

### SECTION A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **Introduction to Steel-Concrete Composite Structures** |
| **2.** | Type of Course | Structural Engineering |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Introduction to composite structures, advantages of composite construction; behaviour of different types of composite columns, axial load capacity and interaction diagram for composite columns.**
**Composite floor system: details of composite deck and shear connectors.**
**Elastic and plastic analysis of composite beams; design of composite beams for serviceability and strength limit states.**

**6.** Course Objectives

- To familiarize the students with different types of steel-concrete composite members, their advantages and structural behaviour
- To enable the students to calculate the axial capacity and interaction diagram of composite columns
- To introduce various components and details of composite floor system
- To familiarize students with the design guidelines of composite beams
- To solve problems related to elastic and plastic analysis of composite beams

**7.** Knowledge required

Preliminary knowledge in steel and concrete structures

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *Understand* the definition, types, advantages and behaviour of steel-concrete composite members | PO(a) | C1 | Lectures, Class participation | Class test, final examination |
| 2 | *Determine* the axial load capacity and load moment | PO(a)<br>PO(b)<br>PO(d) | C4, C5 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | interaction diagram of different types of composite columns | | | | |
| 3 | *Evaluate* the elastic section properties and ultimate capacity of composite beams for various levels of composite interaction | PO(a)<br>PO(b)<br>PO(d) | C4, C6 | Lectures, Class participation | Class test, final examination |
| 4 | *Design* of composite members (floor system, beams and columns) | PO(b)<br>PO(d) | C1, C3, C4 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |
| CO-2 | | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| CO-3 | | | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | | | ✓ | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction and Advantages | Handout | CO1 |
| Lecture 2 | Behaviour and design considerations of fully encased composite (FEC) columns | Handout | CO1 |
| Lecture 3 | Prediction of axial compressive and tensile load capacity of fully encased composite (FEC) columns | Handout | CO2 |
| Lecture 4 | Behaviour and design considerations of concrete filled steel tubular columns (CFST) columns | Handout | CO1 |
| Lecture 5 | Prediction of axial compressive and tensile load capacity of concrete filled steel tubular columns (CFST) columns | Handout | CO2 |
| Lecture 6 | Class Test-1 (Syllabus: Lecture 2 to 5) | | |
| Lecture 7 | Behaviour, design considerations and Prediction of axial load capacity of PEC columns | Handout | CO1<br>CO2 |
| Lecture 8-10 | Formulation of Interaction diagram for composite columns using plastic stress distribution method and interaction equation method. Comparison between the two methods. | Handout | CO1<br>CO2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 11-14 | Solving problems on Interaction diagram for different types of composite column sections (Assignments are given on this topic) | Handout | CO2 |
| Lecture 15-18 | Composite floor system: Components, advantages over conventional RC and steel only construction, design guidelines, construction methods (shored versus unshored construction) and construction sequence. | Handout | CO1 |
| Lecture 19-20 | Composite beams: Behaviour of full and partially composite beams, elastic and plastic analysis of composite beams with and without formed steel deck | Handout | CO1 |
| Lecture 21 | Class Test-2 (Syllabus: Lecture 15- to 20) | | |
| Lecture 22-24 | Shear connectors: purpose of shear connectors, types of connectors, shear capacity and design guidelines for steel headed stud connectors | Handout | CO1 |
| Lecture 25-26 | Solving problems for analysis and design of full and partial composite beams for serviceability and ultimate limit conditions | Handout | CO2 |
| Lecture 27 | Class Test-3 (Syllabus: Lecture 22 to 26) | | |
| Lecture 28 | Review Class | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **Elementary Behavour of Steel and Concrete Composite Structures,** Deric J. Oehlers and Mark A. Bradfrod
2. **Steel Design,** Fifth edition, William T. Segui

**14.** References

1. **Steel Construction Manual,** American Institute for Steel Construction (AISC 2010)
2. **Composite Structures of Steel and Concrete,** Author: R.P. Johnson

## 20.42 Description of Course CE 415

### PART A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | **Prestressed Concrete** |
| **2.** | Type of Course | Structural Engineering |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## PART B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Prestressed Concrete: concepts of prestressing; materials; anchorage systems; loss of prestress; analysis of sections for flexure, shear, bond and bearing; analysis of end block and composite sections; beam deflections; cable layout; partial prestress.**

**Design of prestressed concrete beams for simple and continuous spans; ideas about use of A ASHTO – PCI sections for standard spans; design considerations for prestressed concrete pipes, piles, poles and railway sleepers.**

**6.** Course Objectives

- To introduce application and different methods of prestressing.
- To enable students to analyse flexure, shear, bond and bearing of prestressed concrete.
- To design prestressed concrete beams

**7.** Knowledge required

Preliminary knowledge in concrete structures

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *describe* the concepts of prestressed concrete including prestressing, pre-tensioning and post-tensioning, optimal utilization of high strength materials, anchorage systems and loss of prestress | PO(a) | C1 | Lectures, Class participation | Class test, final examination |
| 2 | *analyze* prestressed sections, end blocks and composite sections for flexure, shear, bond and bearing stress | PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 3 | *calculate* beam deflections at different sections under various loading conditions | PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 4 | *design* prestressed concrete beams for simple and continuous spans | PO(c) | C3 | Lectures, Class participation | Class test, final examination |
| 5 | *explain* ideas about use of AASHTO – PCI sections for standard spans | PO(a) | C2 | Lectures, Class participation | Class test, final examination |
| 6 | *discuss* design considerations for prestressed concrete pipes, piles, poles and railway sleepers | PO(a) PO(c) | C2 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | | | | | | | | | | | | | | | | | | |

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-3 | | ✓ | ✓ | | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | | | | ✓ | | | | | | | | | | | | | | | |
| CO-5 | | | | ✓ | | | | | | | | | | | | | | | | |
| CO-6 | ✓ | | | | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction and Advantages | Handout | CO1 |
| Lecture 2 | Anchorage system | Handout | CO1 |
| Lecture 3-4 | Loss of prestress | Handout | CO1 |
| Lecture 5 | CT-1 | | |
| Lecture 6-7 | Analysis of sections for flexure | Handout | CO2 |
| Lecture 8-9 | Analysis of sections for shear | Handout | CO2 |
| Lecture 10 | Analysis of sections for bond and bearing | Handout | CO2 |
| Lecture 11 | Analysis of end block and composite sections | Handout | CO2 |
| Lecture 12-13 | Beam deflections | Handout | CO3 |
| Lecture 14 | CT-2 | | |
| Lecture 15 | Cable layout | Handout | CO1 |
| Lecture 16 | Partial prestress | Handout | CO1<br>CO2 |
| Lecture 17-19 | Design of prestressed concrete beams for simple and continuous spans | Handout | CO4 |
| Lecture 20 | CT-3 | | |
| Lecture 21-22 | Ideas about the use of AASHTO – PCI sections for standard spans | Handout | CO5 |
| Lecture 23-24 | Design considerations for prestressed concrete pipes, piles, poles, and railway sleepers | Handout | CO6 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

3. **Design of Prestressed Concrete Structures**, Lin Tsung-Yi

**14.** References

Not applicable

## 20.43 Description of Course CE 419

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Introduction to Finite Element Method** |
| **2.** | Type of Course | Structural Engineering |
| **3.** | Offered to | Civil Engineering (Optional) |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Introduction to finite element method as applied to stress analysis problems; basic equations in elasticity, matrix displacement formulation, element shapes, nodes, nodal unknowns and coordinate system, shape functions, strain displacement matrix, methods for assembling stiffness equations e.g., direct approach, Galerkin's method, virtual work method, principle of minimum potential energy; introduction to isoparametric formulation; discritization of a structure and mesh refinement, one dimensional stress-deformation and two dimensional plane stress and plane strain analysis of stress -deformation problems; numerical integration and computer application.**

**6.** Course Objectives

- To introduce finite element method in stress analysis
- To introduce different methods to formulate element stiffness equations and form global stiffness matrix suitable for numerical computation
- To enable student to form strain displacement matrices
- To solve the stress-deformation problems in different discretization methods by employing appropriate constitutive laws and numerical integration strategies to reach efficient but acceptable solutions in terms of desirable accuracy utilizing limited storage and computational resources.

**7.** Knowledge required

Preliminary knowledge in numerical methods.

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *recall* the formulation of differential equations in describing a physical phenomenon. | PO(a) | C1 | Lectures, Class participation | Class test, final examination |
| 2 | *review* the use of constitutive relations and methods of idealizations for representing the linear and non-linear stress-strain responses from a material in addressing a practical three-dimensional structural analysis problem. | PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 3 | *apply* the fundamentals of analysis of statically indeterminate structures by matrix method for stress analysis introducing the concept of shape functions, strain displacement matrix and methods for assembling stiffness equations using different approaches. | PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 4 | *demonstrate* the advantages of use of shape functions in deriving stiffness equations for 1d and 2d elements. | PO(a) | C3 | Lectures, Class participation | Class test, final examination |
| 5 | *differentiate* the advantages (and disadvantages) of isoperimetric formulations. | PO(a) PO(b) | C4 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 6 | *criticize* the advantages (and disadvantages) between different discretization methods, solution methods and numerical integration methods for reaching a solution of a statically indeterminate structural engineering problem in terms of computation time and storage requirements. | PO(a)<br>PO(b) | C5 | Lectures, Class participation | Class test, final examination |
| 7 | *plan* an optimal solution strategy for a statically indeterminate structural engineering problem in terms of computation time and storage requirements. | PO(b) | C6 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | | ✓ | | | | | | | | |
| CO-3 | | ✓ | ✓ | ✓ | | | | | ✓ | | | ✓ | | | | | | | | |
| CO-4 | | ✓ | ✓ | | | | | | ✓ | | | ✓ | | | | | | | | |
| CO-5 | | ✓ | ✓ | | | | | | ✓ | | ✓ | ✓ | | | | | | | | |
| CO-6 | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | |
| CO-7 | | ✓ | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction to finite element method, Basic equations in elasticity, stresses in a typical element | Handout | CO1 |
| Lecture 2 | Equations of equilibrium, strains, strain, displacement equations, linear constitutive law, Idealizations, plane stress problem, plain strain problem, axisymmetric problem | Handout | CO1, CO2 |
| Lecture 3 | Matrix displacement formulation, Element shapes, nodes, nodal unknowns and coordinate systems | Handout | CO1, CO2 |
| Lecture 4 | Shape functions for spring and bar element, Strain displacement matrices | Handout | CO2, CO3, CO4 |
| Lecture 5 | Class Test 1 | | |
| Lecture 6 | Shape function for beam element, strain displacement relation, Beam-Column Elements | Handout | CO3, CO4 |
| Lecture 7 | Assembling stiffness equations in direct approach, Galerkin's method and virtual work method | Handout | CO4 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 8 | Principle of minimum potential energy; introduction to isoparametric formulation | Handout | CO5 |
| Lecture 9 | Class Test 2 | | |
| Lecture 10 | Discretization of structures and mesh refinement: variational formulation in finite element analysis, finite representation of infinite bodies, numbering system to reduce band width, frontal solution technique | Handout | CO6 |
| Lecture 11 | Finite element analysis – bars and trusses: tension bars/columns, two dimensional trusses (plane trusses, three dimensional trusses (space trusses) | Handout | CO6, CO7 |
| Lecture 12 | Finite element analysis – plane stress and plane strain problems: Advantages for higher order elements, | Handout | CO6, CO7 |
| Lecture 13 | Numerical Integration, Computer Applications | Handout | CO6, CO7 |
| Lecture 14 | Class Test 3 | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Finite Element Analysis, S.S Bhavikanti
2. The Finite Element Method: Its Basis and Fundamentals (Sixth Edition), O.C. Zienkiewicz, R.L.Taylor, J.Z. Zhu
3. Fundamentals of Finite Element Analysis, David Hutton

## 20.44 Description of Course CE 421

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Dynamics of Structures** |
| **2.** | Type of Course | Structural Engineering (Optional) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

**Single degree of freedom system, free vibration response; response to harmonic, impulse and general dynamic loading; numerical evaluation of dynamic response; earthquake response of linear system; two degrees of freedom system; response spectrum analysis.**

**6.** Course Objectives

- To introduce single degree of freedom system and two degrees of freedom system
- To evaluate the dynamic response numerically
- To familiarize with earthquake response of linear system
- To solve the problems related to impulse and general dynamic loading

**7.** Knowledge required

Preliminary knowledge in numerical analysis

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *describe* and *apply* the fundamental concepts of system dynamics with specific focus and application to simple civil/structural engineering problems | PO(a) | C2, C3 | Lectures, Class participation | Class test, final examination |
| 2 | *apply* the laws of dynamics to establish mathematical models of single degree of freedom (sdof) and two-dof dynamic problems and evaluate their free vibration characteristics | PO(b) | C3, C4 | Lectures, Class participation | Class test, final examination |
| 3 | *analyze* the dynamic response of a sdof system to various types of dynamic loadings and other important parameters for structural design | PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 4 | *apply* numerical methods to evaluate the response of a sdof systems subjected to general dynamic loadings | PO(b) | C3, C4 | Lectures, Class participation | Class test, final examination |
| 5 | *apply* structural dynamics theory to earthquake analysis, response, and design of structures | PO(b) | C3 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | | ✓ | | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction, Importance of Structural Dynamics, Different types of dynamic loads, Difference between dynamic and static problems, Different mechanical models, fundamental objective of structural dynamics analysis;<br>A Dynamic System: single-degree-of-freedom system (SDOF), components of the basic dynamic system, mass-spring-damper system, Formulation of Equation of Motion (EOM), equation of motion to earthquake excitation. Methods of solution of the differential equation. | Handout | CO1 |
| Lecture 2 | Free vibration of SDOF systems (undamped), Classical solution of EOM, Problems on undamped free vibration response. | Handout | CO1, CO2 |
| Lecture 3 | Free vibration of damped SDOF systems, Classical solution of EOM, under-damped free vibration responses, Logarithmic decrement, Problems on under-damped free vibration responses. | Handout | CO1, CO2 |
| Lecture 4 | Class Test-1.<br>Forced vibration (Harmonic) of undamped SDOF systems, Classical solution of EOM, Steady state vibration, Dynamic magnification factor (DMF). | Handout | |
| Lecture 5 | Problems on forced vibration responses due to harmonic excitation.<br>Forced vibration (Harmonic) of damped SDOF systems, Classical solution of EOM, Steady state vibration, DMF vs Frequency ratio. | Handout | CO2, CO3 |
| Lecture 6 | Problems on forced vibration responses (damped SDOF) due to harmonic excitation.<br>Evaluation of damping in SDOF system. | Handout | CO2, CO3 |
| Lecture 7 | Response of SDOF system to Periodic Loading. Fourier Series Expression, Response to the Fourier Series Loading.<br>Problems on response of SDOF system to Periodic Loading. | Handout | CO2, CO3 |
| Lecture 8 | Class Test-2.<br>Response of SDOF system to Non-periodic Loading (Ideal Step input, Rectangular Pulse loading, Ramp Loading) | Handout | |
| Lecture 9 | Response of SDOF system to short duration Impulse, Unit Impulse Response Function, Response of SDOF systems to general dynamic excitation: Convolutional Integral Method/Duhamel Integral Method)<br>Problems on response of SDOF system to non-periodic Loadings. | Handout | CO2, CO4 |
| Lecture 10 | Response to general dynamic loading: Numerical Method, Integration Method: Constant average acceleration method, linearly varying method, Newmark's Beta Method.<br>Problems on response of SDOF system to general dynamic loading by Newmark's Beta method. | Handout | CO2, CO4 |
| Lecture 11 | Class Test-3. | Handout | |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| | Earthquake Response of a linear system, Equivalent static force, Ground acceleration time history, Response Spectra Concept. | | |
| Lecture 12 | Deformation, pseudo-velocity and pseudo-acceleration Response Spectra, Combined D-V-A Response spectra. Problems on Earthquake response of a linear system using Response spectra. | Handout | CO4, CO5 |
| Lecture 13 | Two Degree of Freedom System, Formulation of EOM of Mass-spring-damper system, 2-DOF shear frame building system, Matrix formulation of EOM. Eigen-value analysis of 2-DOF freedom system, Natural Vibration frequencies and mode shapes. | Handout | CO4, CO5 |
| Lecture 14 | Problem of Eigen-value analysis and determination of natural frequencies and mode shapes.<br>Review of the course. | Handout | CO4, CO5 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **Dynamics of Structures-Theory and applications to earthquake engineering–** Anil K. Chopra, 5th edition, Pearson Education, Inc., Prentice Hall.
2. **Dynamics of Structures,** Ray W. Clough, Joseph Penzien, 3rd edition, Computers & Structures, Inc., Berkley, USA

**14.** References

1. **Dynamics of Structures,** J.L. Humar, 2nd edition, A.A. Balkema Publisher.

## 20.45 Description of Course CE 433

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Solid and Hazardous Waste Management** |
| **2.** | Type of Course | Environmental Engineering (Optional) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Solid Waste Management: sources and types of solid wastes; physical and chemical properties of solid wastes; solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer stations and transport; ultimate disposal methods; resources and energy recovery options; 3R strategy; Solid waste management policy in Bangladesh.

Hazardous Waste Management: identification, sources and characteristics of hazardous wastes; hospital waste management practices; legal aspects; auditing and prevention; methods of treatment and disposal – physical, chemical, biological and thermal treatment; stabilization and solidification, engineering storage, incineration, landfill and deep burial.

**6.** Course Objectives

Educate students on:

a. Collection, characterization, processing, transport and disposal of Municipal Solid and Hazardous Wastes.
b. Design of the MSW collection system.
c. Optimization of the cost of collection and transport system for effective management of solid and hazardous wastes.
d. Operation and management of resource and energy recovery facilities.

**7.** Knowledge required

Preliminary knowledge in environmental engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *describe* the physical and chemical properties, ultimate disposal methods of *solid and hazardous wastes, and decomposition of solid wastes* | PO(a) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *estimate* generation rates of solid and hazardous wastes and the quantity of leachate and gas generation in *a landfill* | PO(a)<br>PO(b) | C5 | Lectures, Class participation | Class test, final examination |
| 3 | *plan and design* the solid and hazardous wastes collection systems and sanitary landfills *based on the type required* | PO(a)<br>PO(b)<br>PO(c) | C6 | Lectures, Class participation | Class test, final examination |
| 4 | *assess* the suitability of different treatment and disposal options of solid and hazardous wastes and *leachate* | PO(a)<br>PO(b)<br>PO(c)<br>PO(f) | C3 | Lectures, Class participation | Class test, final examination |
| 5 | *select* appropriate type of *solid and hazardous waste management methods* | PO(a)<br>PO(b)<br>PO(c)<br>PO(f) | C4 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-3 | | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-4 | | | | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |
| CO-5 | | | | ✓ | ✓ | | ✓ | | | | | | | | | | | | | |

**10.** Lecture Plan

| **Class No.** | **Topics** | **References** | **Corresponding CO(s)** |
|---|---|---|---|
| Lecture 1 | Introduction to solid waste scenario of Bangladesh; identification of sources and classification of different components. | Handout | CO1 |
| Lecture 2 | Physical properties of solid waste; methods of assessing physical properties of solid waste | Handout | CO1 |
| Lecture 3-4 | Chemical properties of solid waste; methods of assessing chemical properties of solid waste, estimating the chemical composition of the organic fraction of solid waste | Handout | CO1 |
| Lecture 5 | Biological properties of solid waste, analysis of biodegradability of solid waste; assessing the energy value of solid waste | Handout | CO1 |
| Lecture 6-7 | Mass balance analysis of resources and generated industrial wastes; assessment of solid waste generation rate of a community; on-site handling methods, sorting and storage provisions | Handout | CO2 |
| Lecture 8 | Description of solid waste collection systems, mathematical models for assessing the different methods of collection, estimating the collection vehicle capacity | Handout | CO3 |
| Lecture 9 | Class test-1 | | |
| Lecture 10 | Description of transfer and transport systems, comparison of collection systems and transfer & transport systems based on cost | Handout | CO3 |
| Lecture 11-12 | Waste load allocation among the transfer stations and disposal sites; types of MRFs, units of operations used at MRFs, equipment used for size reduction at MRFs, energy recovery from MSW | Handout | CO3 |
| Lecture 13 | Review | Handout | |
| Lecture 14 | Class test-2 | Handout | |
| Lecture 15 | Ultimate disposal methods of solid wastes, Solid Waste Disposal in Low-Income Countries; | Handout | CO1 |
| Lecture 16 | Landfill Development Levels; Sanitary Landfill and Landfilling Methods; Advantages and disadvantages of sanitary landfill | Handout | CO1<br>CO4 |
| Lecture 17 | Planning and Design of a Sanitary Landfill; Site Selection; Operational Manual; Layout plan of a sanitary landfill | Handout | CO3 |
| Lecture 18 | Decomposition of Solid Wastes in Landfills; Characteristics of Leachate; Leachate Migration | Handout | CO2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 19 | Leachate Quantities, Leachate Control, Leachate Collection System, | Handout | CO2<br>CO3 |
| Lecture 20 | Leachate Treatment; Leachate Recirculation; Final Disposal of Leachate; Stormwater Management | Handout | CO4 |
| Lecture 21 | Environmental impacts of landfill gases; Composition of Landfill Gas; Stages of Landfill Gas Generation | Handout | CO2 |
| Lecture 22 | Quantity of Landfill Gas Generation; Control of Gas Movement; | Handout | CO2 |
| Lecture 23 | Gas Recovery; Resource Recovery from Solid Waste; Recycling Process in Bangladesh | Handout | CO1 |
| Lecture 24 | Hazardous Wastes; Human Exposure Pathways for Hazardous Wastes; Hazardous Wastes Screening; Review of Treatment and Disposal Options for Hazardous Wastes | Handout | CO4 |
| Lecture 25 | Advantages, Disadvantages and Limitations of Physical, chemical, thermal and Biological Treatment Processes of hazardous wastes; Landfill for final Disposal of Hazardous Wastes | Handout | CO4<br>CO5 |
| Lecture 26 | Classification of Hospital Wastes; Collection, storage and Transportation; Treatment and Disposal | Handout | CO1 |
| Lecture 27 | Review | Handout | |
| Lecture 28 | Class test-3 | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of Academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **Integrated Solid Waste Management : Engineering Principles And Management Issues** by George Tchobanoglous, Hilary Theisen, Samuel Vigil
2. **Hazardous Waste Management** by Charles A. Wentz
3. **Solid Waste Engineering** by P. A. Vesilind, W. Worrell & D. Reinhart
4. **Text Book of Solid Wastes Management** by I. H. Khan & N. Ahsan
5. **Environmental Engineering** by H. S. Peavy, D. R. Rowe & G. Tchobanoglous
6. **Water Supply & Sanitation** by M. F. Ahmed & M. M. Rahman

**14.** References

1. **Environmental Engineering by** A. P. Sincero & G. A. Sincero

## 20.46 Description of Course CE 435

### SECTION A: General Information

**1.** Course Title — **Environmental Pollution Management**

**2.** Type of Course — Environmental Engineering (Optional)

**3.** Offered to — Civil Engineering

**4.** Pre-requisite Course(s) — None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Water pollution: sources and types of pollutants, emerging contaminants; waste assimilation capacity of streams; dissolved oxygen modelling; ecological balance of streams; industrial pollution; lake pollution and eutrophication; heavy metal contamination; groundwater pollution; marine pollution; water quality problems in Bangladesh; pollution control measures: water quality monitoring and management.

Air pollution: sources and types of pollutants; effects of various pollutants on human health, materials and plants; air pollution meteorology; introduction to air quality models; air pollution monitoring and control measures; global warming, climate change and ozone layer depletion; acid rain.

Noise pollution and control measures.

**6.** Course Objectives

- To synthesize the sources and nature of pollution e.g., air pollution and water pollution
- To introduce problems associated with environmental pollution
- To familiarize with pollution control measures

**7.** Knowledge required

Preliminary knowledge in environmental engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *classify* sources of air and water pollution and *describe* their formation and effects | PO(a) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *apply* simple dissolved oxygen (DO) analytical model to assess the effect of organic loading on DO and simple models for pollutant transport through subsurface | PO(b) | C3 | Lectures, Class participation | Class test, final examination |
| 3 | *describe* groundwater quality problems in Bangladesh and their remedial measures | PO(b)<br>PO(f)<br>PO(g) | C2 | Lectures, Class participation | Class test, final examination |
| 4 | *analyze* the effects of meteorology on air quality and *apply* Gaussian plume model to assess effects of emissions from point and line sources on air quality | PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 5 | *identify* and *describe* control measures for reduction of pollutant load from pollution | PO(a)<br>PO(f)<br>PO(g) | C4 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | sources of water and air pollution | | | | |
| 6 | *describe* the role of GHGs and particulates in regulating climate change/global warming | PO(a) | C2 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | | | | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| CO-4 | ✓ | | ✓ | | | | | | | | | | | | | | | | | |
| CO-5 | | | | ✓ | | | ✓ | | | | | | | | | | | | | |
| CO-6 | | | | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Water Pollution and its effect: Global and Bangladesh Perspective | Handout | CO1 |
| Lecture 2 | Water pollution: sources and types of pollutants, | Handout, Masters | CO1 |
| Lecture 3 | Waste assimilation capacity of streams, control of surface water pollution | Handout, Masters | CO1 |
| Lecture 4-5 | Dissolved oxygen modeling; ecological balance of streams | Handout, Masters | CO2 |
| Lecture 6 | Class Test 1 | | |
| Lecture 7-8 | Lake water quality, detergent pollution and eutrophication | Handout, Masters | CO1 |
| Lecture 9-10 | Groundwater quality, pollutant fate and transport through ground water, control of ground water pollution | Handout, Masters | CO1<br>CO3<br>CO5 |
| Lecture 11 | Water quality in Bangladesh: contamination and control of pollution | Handout | CO3<br>CO5 |
| Lecture 12 | Class Test 2 | | |
| Lecture 13-15 | Air pollution: sources and types of pollutants | Handout | CO1 |
| Lecture 16-18 | Formation and effects of various pollutants on human health, materials and plants; | Handout | CO1 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 19 | Class Test-3 | | |
| Lecture 20-21 | Air pollution meteorology; | Handout | CO4 |
| Lecture 22 | Global warming, climate change and ozone layer depletion | Handout | CO6 |
| Lecture 23-24 | Air pollution monitoring and control measures | Handout | CO4<br>CO5 |
| Lecture 25-27 | Introduction to air quality models; application of Gaussian Plume model for point and line sources of pollution. | Handout | CO4 |
| Lecture 28 | Class Test-4 | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **Introduction to Environmental Engineering and Science,** Third edition, by Gilbert M. Masters and Wendell P. Ela, Pearson Prentice Hall.
2. Class Lecture Handout

**14.** References

1. **Introduction to Environmental Engineering**, Fifth edition, by Mackengie L. Davies and David A. Cornwell, Mc Graw Hill Education.

## 20.47 Description of Course CE 437

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Basic Environmental Management** |
| **2.** | Type of Course | Environmental Engineering (Optional) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Introduction to environmental management; environmental policies, legislative and institutional framework; environmental implication of sectoral development; environmental quality standards; environmental impact assessment of development projects; strategic environmental assessment; environmental auditing; economics of environmental management; case studies.

**6.** Course Objectives

The objective of the course is to relate environment with development activities and demonstrate the need for sustainable development. The course will emphasize on learning about different environmental and social impacts of development activities, tools to quantify or assess impacts and devising cost-effective and feasible mitigation measures to address the impacts. The role of policies, laws and institutions in the context of environmental management will also be discussed.

**7.** Knowledge required

Preliminary knowledge in environmental engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *relate* environment with development activities and distinguish between development and sustainable development | PO(a)<br>PO(f)<br>PO(g) | C4, A4 | Lectures, Class participation | Class test, final examination |
| 2 | *demonstrate* the knowledge of and need for sustainable development and environmental management | PO(a)<br>PO(f)<br>PO(g) | C3 | Lectures, Class participation | Class test, final examination |
| 3 | *assess* the environmental impacts of development projects | PO(a)<br>PO(c)<br>PO(f)<br>PO(g) | C5 | Lectures, Class participation | Class test, final examination |
| 4 | *comprehend* the role of policy and legislative framework of Bangladesh in environmental management | PO(g) | C2 | Lectures, Class participation | Class test, final examination |
| 5 | *explain* the economics of environmental management | PO(a)<br>PO(b)<br>PO(f)<br>PO(g) | C2 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | | | | | ✓ | | | | | | | | | | | | √ | |
| CO-2 | ✓ | | | | | | ✓ | | | | | | | | | | | | √ | |
| CO-3 | | ✓ | | | | | ✓ | ✓ | | | | | | | | | | | √ | |
| CO-4 | | | | | | | ✓ | | | | | | | | | | | | √ | |
| CO-5 | ✓ | ✓ | | | | | ✓ | | | | | | | | | | | | √ | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Man - Environment Interactions and Human Carrying Capacity of Earth and Ecological Footprint | Handout | CO1 |
| Lecture 2 | Introduction to Environmental Management | Handout | CO1 |
| Lecture 3 | Development and Sustainable Development | Handout | CO1 |
| Lecture 4 | Goals of Sustainable Development and Business tools to achieve sustainability | Handout | CO1 |
| Lecture 5 | MDG, SDG and Delta Plan 2100 | Handout | CO1 |
| Lecture 6 | Environmental Issues: Global, Regional and Local (Causes, Impacts, Mitigation measures) | Handout | CO2 |
| Lecture 7 | Class Test-1,<br>Priorities of Environmental Issues in the context of Bangladesh | Handout | CO2 |
| Lecture 8 | Environmental Implications of Sectoral Development: Agricultural, Industrial, Energy Sector | Handout | CO1<br>CO3 |
| Lecture 9 | Environmental Implications of Sectoral Development: Transportation and Communication, Tourism, Infrastructure, Flood control and Drainage | Handout | CO1<br>CO3 |
| Lecture 10 | Environmental Impact Assessment Methodologies | Handout | CO3 |
| Lecture 11-12 | Evaluation of environmental impacts due to specific development projects | Handout | CO3 |
| Lecture 13 | Class test-2 | | |
| Lecture 14 | Review | | |
| Lecture 15 | History and context of Environmental legislation in Bangladesh, Features of Bangladesh Environmental Policy 1992 and 2013 | Handout | CO4 |
| Lecture 16 | Bangladesh Environment Conservation Act 1995, its salient features and its role in environmental management in Bangladesh, environmental clearance procedures for industrial projects | Handout | CO4 |
| Lecture 17 | The role of judiciary, civil society and Public interest litigation in environmental management, salient features of the Environment Court Act 2010 | Handout | CO4 |
| Lecture 18 | Other key environmental legislations (Water Act 2013, Brick Manufacturing and Kiln Act 2013, Hazardous Waste and Ship-breaking Waste Management Rules 2011) | Handout | CO4 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 19 | Guidelines and standards, setting environmental Quality Standards, Salient features Environmental Conservation Rules 1997 | Handout | CO4 |
| Lecture 20 | Laws Related to Workplace health and safety, international treaties and protocols, review of environmental laws | Handout | CO4 |
| Lecture 21 | Class test-3 | | |
| Lecture 22 | EIA and Project Cycle, IEE and EIA | Handout | CO3 |
| Lecture 23 | Environmental Management Plan, Environmental Monitoring | Handout | CO3 |
| Lecture 24 | Public Participation in Environmental Decision-making | Handout | CO4 |
| Lecture 25 | Case studies in EIA: The Jamuna Multipurpose Bridge Project | Handout | CO3 |
| Lecture 26 | Economics of environmental management: willingness-to-pay and opportunity cost, equimarginal principle, socially efficient rate of output | Handout | CO5 |
| Lecture 27 | Economics of environmental management: marginal damage function and abatement costs, efficient level of emissions | Handout | CO5 |
| Lecture 28 | Class test-4 | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of Academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. **Environmental Impact Assessment** by Larry W. Canter
2. **Environmental Economic**s by Field and Olewiler
3. Class Lecture Handout

**14.** References

1. Environmental Management for Sustainable Development by C.J. Barrow
2. http://cpd.org.bd/wp-content/uploads/2015/10/The-Agenda-of-Sustainable-Development-Goals-Implementation-Challenges-for-Bangladesh-CPD-Debapriya-Bhattacharya.pdf
3. https://www.academia.edu/8965675/Analyze_the_Major_Challenges_of_Sustainable_Development_in_Bangladesh

4. http://www.climatechangecell.org.bd/Documents/climate_change_strategy2009.pdf
5. http://www.world-nuclear.org/info/Energy-and-Environment/Environment-and-Health-in-Electricity-Generation/
6. GoB (1997), Environmental Conservation Rules 1997, Department of Environment, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, June 1997.
7. GoB (1995), Environment Conservation Act 1995, Department of Environment, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh.
8. GoB (1997), EA Guidelines for Industries, Department of Environment, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, June 1997.
9. GoB (2005), SRO No. 220-Rule/2005, Revision of the Environment Conservation Rules 1997, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, Dhaka.
10. "Construction-related environmental impacts of the Jamuna multipurpose bridge project" by ABM Badruzzaman and M Feroze Ahmed (Journal of Civil Engineering, IEB)
11. "Environmental impact assessment of Jamuna multipurpose bridge project" by M. Feroze Ahmed and Tanvir Ahmed

## 20.48 Description of Course CE 441

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Foundation Engineering** |
| **2.** | Type of Course | Geotechnical Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Soil investigation techniques; types of foundations; bearing capacity of shallow and deep foundations; settlement and distortion of foundations; design and construction of footings, rafts and piles; slope stability analyses.

**6.** Course Objectives

- To introduce sub-soil investigation program for various Civil Engineering Projects
- To introduce several limit equilibrium methods for stability check and design of slopes
- To enable designing footings, raft and piles foundations.

**7.** Knowledge required

Preliminary knowledge in geotechnical engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | Plan sub-soil investigation program and prepare sub-soil investigation report for various civil engineering projects | PO(a), PO(d) | C6 | Lectures, Class participation | Class test, final examination |
| 2 | Analyse an existing slope to check its stability using several limit equilibrium methods & design new earth slopes | PO(b), PO(c) | C4 | Lectures, Class participation | Class test, final examination |
| 3 | Determine the bearing capacity for shallow and deep foundations for homogeneous or layered soil | PO(b) | C4 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 4 | Evaluate the total settlement of a footing or pile group in sand or clay | PO(a), PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 5 | Decide on appropriate types of foundation for a structure and design footings, raft or piles foundations | PO(c) | C5, C6 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-5 | | | | | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| **Class No.** | **Topics** | **References** | **Corresponding CO(s)** |
|---|---|---|---|
| Lecture 1-7 | Soil investigation techniques | Handout, Text Book. | CO-1 |
| Lecture 8-13 | Slope stability analyses | Handout, Text Book. | CO-2 |
| Lecture 14-22 | Types of foundations; bearing capacity of shallow and deep foundations | Handout, Text Book. | CO-3 |
| Lecture 23-28 | Settlement and distortion of foundations | Handout, Text Book. | CO-4 |
| Lecture 29-38 | Design and construction of footings, raft and piles | Handout, Text Book. | CO-5 |
| | 04 lectures for Class test | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least four class tests will be administered. Best three of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

a. Principles of Foundation Engineering
*-B. M. Das, 9th Edition, January 2018, Cengage Learning*

b. Foundation Engineering
*-W. E. Hanson, T. H. Thornburn, R. B. Peck, 2nd Edition, January 1991, Wiley*

**14.** References

*a.* Physical and Geotechnical Properties of Soils
*-Joseph E. Bowels, 2nd Edition, March 1984, McGraw-Hill*

b. Geotechnical Engineering: Principles and Practices
*-Donald P. Coduto, 2nd Edition January 2010, Pearson*

c. Development in Geotechnical Engineering
*-B. M. Das, Nagaratnam Sivakugan, 2016-2022, Springer*

## 20.49 Description of Course CE 443

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Earth Retaining Structures** |
| **2.** | Type of Course | Geotechnical Engineering (Compulsory) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

**SECTION B: Course Details**

**5.** Course Content (As approved by the Academic Council)

Foundation of structures subjected to lateral loads; rigid and flexible earth retaining structures; methods of construction: dewatering and slurry-wall construction, braced excavation, sheet piles, cofferdams, caissons.

**6.** Course Objectives

- To introduce different earth retaining structures along with their importance.
- To enable applying earth pressure theories for designing earth retaining structures
- To familiarize with basic principles of construction dewatering.

**7.** Knowledge required

Preliminary knowledge in geotechnical engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | Understand basic principles of construction dewatering and slurry trench wall construction | PO(a), PO(c) | C1 | Lectures, Class participation | Class test, final examination |
| 2 | Apply basic concepts of lateral earth pressure theory for analysis and design of flexible and rigid earth retaining structures | PO(b), PO(c) | C3 | Lectures, Class participation | Class test, final examination |
| 3 | Analyze shallow and deep foundations subjected to lateral loads | PO(b), PO(c) | C4 | Lectures, Class participation | Class test, final examination |
| 4 | Analyze and design of cofferdams, caissons and mechanically stabilized walls | PO(b), PO(c) | C4, C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction | Handout, Text Book. | |
| Lecture 2-4 | Methods of construction dewatering | Handout, Text Book. | CO-1 |
| Lecture 5 | Slurry-wall construction | Handout, Text Book. | CO-1 |
| Lecture 6-9 | Flexible earth retaining structures: sheet piles | Handout, Text Book. | CO-2 |
| Lecture 10-11 | Laterally loaded Piles | Handout, Text Book. | CO-3 |
| Lecture 12-13 | Foundation of Structures Subjected to Lateral Loads | Handout, Text Book. | CO-3 |
| Lecture 14-17 | Rigid and Flexible Earth Retaining Structures | Handout, Text Book. | CO-2 |
| Lecture 18-20 | Cofferdams | Handout, Text Book. | CO-4 |
| Lecture 21-22 | Mechanically Stabilized Wall | Handout, Text Book. | CO-4 |
| Lecture 23-24 | Class test (3 nos.) & course review | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

a. Foundation Design
*-Wayne C. Teng, 13th Edition, February 1992, Prentice-Hall*

b. Foundation Analysis and Design
   -*Joseph E. Bowles, 5th Edition, 1996, McGraw Hill*
c. Earth Pressure and Earth Retaining Structures
   - *Chris R.I. Clayton, 3rd Edition, May 2014, CRC Press*
d. Foundation and Earth Retaining Structures
   - *Muni Budhu, 1st Edition, January 2008, Wiley*
e. Basics of Retaining Wall Design - *Hugh Brooks, 11th Edition, May 2018, HBA Publications*

**14.** References

Lecture materials and Handouts provided by course teacher

## 20.50 Description of Course CE 445

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Elementary Soil Dynamics** |
| **2.** | Type of Course | Geotechnical Engineering (Optional) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Elementary vibrations; dynamic properties of soil; seismic response of soils: site effects, site amplification, liquefaction problems, remedial measures and earthquake hazards.

**6.** Course Objectives

- To introduce basic concepts of soil dynamics and earthquake related problems
- To demonstrate liquefaction problems and discuss different remedial measures.
- To enable estimating dynamic properties of soil from experimental data as well as response curve.

**7.** Knowledge required

Preliminary knowledge in geotechnical engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | Explain the basic concepts of soil dynamics, controlling factors, response on displacement, load vectors, causes of earthquakes, vibration measurements, site amplification and seismic response for a flat ground | PO(a) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | Apply the concepts of dynamic analysis to analyze deflections (i.e., the displacement vector) and various force components under various practical ranges of damping and frequency ratio. | PO(a) | C3 | Lectures, Class participation | Class test, final examination |
| 3 | Demonstrate liquefaction problems and discuss different remedial measures. | PO(b), PO(c) | C3 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 4 | Estimate the dynamic parameters of soils using experimental data as well as response curve under dynamic states and earthquake hazards | PO(b), PO(d) | C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1-2 | Introduction to soil dynamics and site effects | Handout, Text Book. | CO-1 |
| Lecture 3-5 | Site amplifications and seismic response | Handout, Text Book. | CO-1 |
| Lecture 6-9 | Liquefaction problems and remedial measures | Handout, Text Book. | CO-3 |
| Lecture 10-13 | Earthquake hazards | Handout, Text Book. | CO-4 |
| Lecture 14-15 | Dynamic soil parameters: soil modulus, Poisson’s ratio and damping ratio; basic factors affecting these parameters from static to dynamic cases; some laboratory and field evaluation techniques. | Handout, Text Book. | CO-2 |
| Lecture 16 | Definition of damping ratio of soil and its estimation from laboratory static tests as well as from dynamic responses; practical range of damping ratio of soil under dynamic states. | Handout, Text Book. | CO-2 |
| Lecture 17-18 | Basic idealization of soil problem using lump-mass method and force equilibrium under dynamic loading system | Handout, Text Book. | CO-2 |
| Lecture 19-20 | Definition of Free and force vibrations; various types of free and forced vibrations under single degree of freedom SDOF | Handout, Text Book. | CO-2 |
| Lecture 21-22 | Response analysis of SDOF system under forced vibration with constant excitation force and frequency dependent excitation force. | Handout, Text Book. | CO-2 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 23-24 | Problem solving class on basic parameters, response characteristics. | Handout, Text Book. | CO-4 |
| | 4 lectures for Class test (3 nos.) & course review | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

a. Earthquake Geotechnical Engineering: Stephan Krammer
b. Soil Dynamics: Shamsher Prakash
c. Dynamics of Foundation Schmidt

**14.** References

a. Earthquake Geotechnical Engineering
b. Foundation Engineering by VNS Murthy

## 20.51 Description of Course CE 447

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | **Soil Water Interaction** |
| **2.** | Type of Course | Geotechnical Engineering (Optional) |
| **3.** | Offered to | Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Introduction to soil-water interaction problems: permeability, capillarity and soil suction; slopes subjected to water current, wave action etc; theories of filters and revetment design; geotechnical design of landfills.

**6.** Course Objectives

- To introduce soil-water interaction related problems (i.e. seepage)
- To familiarize seepage control measures.
- To enable deciding on appropriate type of soil improvement methods for various projects

**7.** Knowledge required

Preliminary knowledge in geotechnical engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | Determine laboratory and field permeability of soils and seepage quantity for an earth dam | PO(a), PO(b) | C4 | Lectures, Class participation | Class test, final examination |
| 2 | Design the cover layer of revetment for river bank protection | PO(c) | C6 | Lectures, Class participation | Class test, final examination |
| 3 | Assess the factor of safety of slopes subjected to seepage | PO(a), PO(b) | C6 | Lectures, Class participation | Class test, final examination |
| 4 | Design granular and geotextile filters for seepage control | PO(c) | C6 | Lectures, Class participation | Class test, final examination |
| 5 | Decide on appropriate type of hydraulic fill and suitable improvement methods for various projects | PO(a), PO(c) | C5 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-2 | | | | | ✓ | | | | | | | | | | | | | | | |
| CO-3 | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| CO-5 | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| **Class No.** | **Topics** | **References** | **Corresponding CO(s)** |
|---|---|---|---|
| Lecture 1 | Introduction to soil-water interaction problems | Handout, Text Book. | CO-1 |
| Lecture 2-10 | Permeability, capillarity and soil suction | Handout, Text Book. | CO-2 |
| Lecture 11 | Slopes subjected to water current wave action etc. | Handout, Text Book. | CO-3 |
| Lecture 12-13 | Revetment design | Handout, Text Book. | CO-2 |
| Lecture 14-19 | Theories of filters | Handout, Text Book. | CO-4 |
| Lecture 20-24 | Geotechnical design of landfills | Handout, Text Book. | CO-5 |
| | 4 lectures for Class test (3 nos.) & course review | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

a. Seepage, Drainage and Flow Nets: Harry R Cedergren
b. Designing with geosynthetics: Robert M Koerner
c. Hydraulic fill structures, Geotechnical special publication no.21, eds. D J A Van Zyl and Steven G Vick

**14.** References

a. Hydraulic fill manual: Hoff and Kolff

## 20.52 Description of Course CE 451

### SECTION A: General Information

**1.** Course Title Transportation Engineering II: Pavement Design and Railway Engineering
**2.** Type of Course Transportation Engineering (Compulsory)
**3.** Offered to Civil Engineering
**4.** Pre-requisite Course(s) None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Pavement materials: bituminous binders, cement, aggregates, embankment material, soil stabilization; mix design methods; low-cost roads; flexible and rigid pavement: pavement components and functions, pavement design and construction, road maintenance; railway engineering: general requirements, rolling stock and tracks, stations and yards, points and crossings, signalling, maintenance operations.

**6.** Course Objectives

- To introduce different layers and constituents of flexible and rigid pavements, railway and design parameters
- To learn to determine suitable pavement materials for low-cost road considering the socio-economic condition of Bangladesh.
- To learn to analyze material properties and structural distress for pavement and railway track; perpetual pavement system for developing sustainable pavement system
- To learn to design hot mix asphalt using standard methods, flexible and rigid pavements using different empirical, semi-empirical and theoretical approaches and railway signal layout

**7.** Knowledge required

Preliminary Knowledge in Transportation Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *explain* different layers and constituents of flexible and rigid pavements, the function of layers, load distribution mechanism, design principles of pavement systems, roadway furniture, uses of construction equipment and components of permanent way of railway | PO(a) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *determine* suitable pavement materials for low-cost road considering the socio-economic condition of Bangladesh; resistances on rolling stock | PO(a)<br>PO(f) | C4, C5 | Lectures, Class participation | Class test, final examination |
| 3 | *analyze* material properties and structural distress for pavement and railway track; perpetual pavement system for developing sustainable pavement system | PO(b) | C5 | Lectures, Class participation | Class test, final examination |
| 4 | *design* hot mix asphalt using standard methods, flexible and rigid pavements using different empirical, semi-empirical and theoretical approaches and railway signal layout | PO(c) | C6 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-2 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-3 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction of Pavement materials, uses and their importance | Text Book, Handout | CO3 |
| Lecture 2-3 | Type, uses, properties, tests and uses of course aggregates | Text Book, Handout | CO3 |
| Lecture 4-5 | Type, uses, properties, tests and uses of fine aggregates | Text Book, Handout | CO3 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 6-9 | Type, uses, properties, tests and uses of bituminous binders | Text Book, Handout | CO3 |
| Lecture 10 | Properties and uses of Cement and embankment materials | Text Book, Handout | CO3 |
| Lecture 11-12 | Mix design methods of asphaltic concrete | Text Book, Handout | CO4 |
| Lecture 13 | Review | Text Book, Handout | |
| Lecture 14 | Class test | Text Book, Handout | |
| Lecture 15 | Pavement Definition; History of Pavement; Pavement Types; | Text Book, Handout | CO1 |
| Lecture 16 | Layer systems of Flexible, Rigid and Semi-Rigid Pavement; Functions of pavement courses; Load distribution mechanism; | Text Book, Handout | CO1 |
| Lecture 17 | Comparison of flexible and rigid pavements; | Text Book, Handout | CO1 |
| Lecture 18-19 | Stresses and Distresses of flexible & rigid pavements; | Text Book, Handout | CO3 |
| Lecture 20 | Technique of developing Perpetual Pavement System; | Text Book, Handout | CO3 |
| Lecture 21 | Design of pavements: Outcomes of AASHO road test, Design principles, Characteristics of traffic load, Concept of ESAL, | Text Book, Handout | CO4 |
| Lecture 22-23 | Forecasting design traffic load; Flexible pavement: RHD, TRL, AASHTO methods etc.; | Text Book, Handout | CO4 |
| Lecture 24-25 | Rigid pavement: RHD, TRL, PCA, AASHTO methods etc.; | Text Book, Handout | CO4 |
| Lecture 26 | Rigid Pavement Joints; Reinforcement design. | Text Book, Handout | CO4 |
| Lecture 27 | Review | | |
| Lecture 28 | Class tests | | |
| Lecture 29 | Low cost road: introduction, example cases, types, | Text Book, Handout | CO2 |
| Lecture 29 | Low cost road: materials, construction | Text Book, Handout | CO2 |
| Lecture 30 | Low cost road: maintenance, Bangladesh perspectives | Text Book, Handout | CO2 |
| Lecture 31 | Equipment: highway and transportation projects | Text Book, Handout | CO1 |
| Lecture 32 | Construction of embankment: earthwork, cut and fill, dry fill vs. Wet fill, compaction, quality control and assurance | Text Book, Handout | CO1 |
| Lecture 33 | Construction, subgrade | Text Book, Handout | CO1 |
| Lecture 34 | Construction of, base, | Text Book, Handout | CO1 |
| Lecture 35 | Construction of flexible surface | Text Book, Handout | CO1 |

| | | | |
|---|---|---|---|
| Lecture 36 | Construction of flexible surface | Text Book, Handout | CO1 |
| Lecture 37 | Construction of rigid surface | Text Book, Handout | CO1 |
| Lecture 38 | Maintenance of flexible road pavements | Text Book, Handout | CO1 |
| Lecture 39 | Maintenance of flexible road pavements | Text Book, Handout | CO1 |
| Lecture 40 | Maintenance of rigid road pavements | Text Book, Handout | CO1 |
| Lecture 41 | Class Test, Wrapping Up and Showing of Road Construction Videos | | |
| Lecture 42 | Introduction | Text Book, Handout | |
| Lecture 43 | Rail Resistance | Text Book, Handout | CO2 |
| Lecture 44 | Different types of railway gauges | Text Book, Handout | CO3 |
| Lecture 45 | Deferent types of rail | Text Book, Handout | CO3 |
| Lecture 46 | Rail fastening | Text Book, Handout | CO3 |
| Lecture 47 | Sleepers | Text Book, Handout | CO3 |
| Lecture 48 | Ballast | Text Book, Handout | CO3 |
| Lecture 49 | Formation | Text Book, Handout | CO3 |
| Lecture 50 | Maintenance of railway track | Text Book, Handout | CO3 |
| Lecture 51 | Curvature | Text Book, Handout | CO3 |
| Lecture 52 | Brakes | Text Book, Handout | CO3 |
| Lecture 53 | Railway stations and yards | Text Book, Handout | CO4 |
| Lecture 54 | Points and crossing | Text Book, Handout | CO4 |
| Lecture 55 | Class test, Signalling and interlocking | | CO4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Highway Engineering by Paul H. Wright
2. Principles of Pavement design by E.J. Yoder
3. Transportation Engineering and Transport Planning by L.R.Kadiyali
4. Low Volume Rural Road Surfacing and Pavements A Guide to Good Practice; By: J R Cook, R C Petts, J Rolt
5. Construction practices and procedures manual, RHD, Ministry of Road Transport and Bridges, GOB
6. Railway Engineering: S. C. Rangwala
7. Railway Engineering: M. M. Agarwal
8. A Text Book of Railway Engineering: S.C.Saxena and S.P.Arora
9. Information Book: Bangladesh Railway

**14.** References

Class Note

## 20.53 Description of Course CE 452

**SECTION A: General Information**

**1.** Course Title **Transportation Engineering Sessional I: Highway Materials and Traffic Engineering Design**

**2.** Type of Course Transportation Engineering (Compulsory)

**3.** Offered to Civil Engineering

**4.** Pre-requisite Course(s) None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Testing and quality control of highway materials; bituminous mix design; roadway traffic and capacity analysis; computer models and application packages.

**6.** Course Objectives

- To introduce to perform experiments related to roadway embankment and bituminous pavement materials
- To learn to perform experiments related to roadway embankment and bituminous pavement materials
- To introduce asphalt mix design using standard guidelines and practices

**7.** Knowledge required

Preliminary Knowledge in Transportation Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| **CO No.** | **CO Statement** | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| 1 | *perform* experiments related to roadway embankment and bituminous pavement materials | PO(a) | C2 | Lectures, Class participation | Class Assessments, Lab Reports, Viva, Quiz |
| 2 | *estimate, analyze* and *report* the roadway capacity and signal design parameters using experimental data | PO(a)<br>PO(b)<br>PO(d) | C2, C4 | Lectures, Class participation | Class Assessments, Lab Reports, Viva, Quiz |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 3 | *design* asphalt mix using standard guidelines and practices | PO(a)<br>PO(c) | C6 | Lectures, Class participation | Class Assessments, Lab Reports, Viva, Quiz |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | ✓ | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | ✓ | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | 1.1 Determination of Aggregate Impact Value<br>1.2 Determination of Aggregate Crushing Value<br>1.3 Determination of Ten Percent Fines Value | Handout | CO1 |
| Lecture 2 | 1.4 Determination of Flakiness Index<br>1.5 Determination of Elongation Index<br>1.6 Determination of Angularity Number | Handout | CO1 |
| Lecture 3 | 2.1 Specific Gravity of Semi-Solid Bituminous Material<br>2.2 Loss on Heating of Oil and Asphaltic Compounds | Handout | CO1 |
| Lecture 4 | 2.3 Penetration of Bituminous Material<br>2.4 Softening Point of Bituminous Material | Handout | CO1 |
| Lecture 5 | 2.5 Solubility of Bituminous Material<br>2.6 Ductility of Bituminous Material<br>2.7 Flash and Fire Points of Bituminous Material (Cleaveland open cup) | Handout | CO1 |
| Lecture 6 | MID QUIZ | | |
| Lecture 7 | 3.1 Determination of Roadway Capacity | Handout | CO2 |
| Lecture 8 | 3.2 Determination of Saturation Flow at Traffic Signals | Handout | CO2 |
| Lecture 9-10 | 4.1 Determination of CBR | Handout | CO1 |
| Lecture 11-12 | 4.2 Marshall Mix Design | Handout | CO3 |
| Lecture 13 | Determination of Los Angeles Abrasion Value | Handout | CO1 |
| Lecture 14 | Final Quiz | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Assessment: A short class assessment will be administered prior to each lecture. Average marks obtained from those will be counted towards grading.
- Viva: Two oral viva sessions will be held at the middle and the end of the term respectively.
- Quiz: Two comprehensive sessional quizzes will be held at the middle and the end of the term respectively following the guideline of Academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Lab Report | 15% |
| Class Assessment | 20% |
| Viva | 5% |
| Quiz | 50% |

**13.** Textbook

1.Traffic and Highway Engineering, FOURTH EDITION by Nicholas J. Garber and Lester A. Hoel

**14.** References

1. Lecture Notes on CE 452

## 20.54 Description of Course CE 455

**SECTION A: General Information**

**1.** Course Title **Transportation Engineering IV: Pavement Management, Drainage and Airport**

**2.** Type of Course Transportation Engineering (Optional)

**3.** Offered to Civil Engineering

**4.** Pre-requisite Course(s) None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

Pavement management systems; evaluation and strengthening of pavements; drainage: highway drainage and drainage structures; airports: importance, advantages and trends in air transportation, planning and design of airports, aircraft characteristics related to airport design, types and elements of airport planning studies, airport configuration, geometric design of the landing area, terminal area, heliports, design of airport pavements, lighting, marking and signing, airport drainage

.

**6.** Course Objectives

- To introduce key aspects of airport design and operations along with its main elements and master plan
- To introduce the design the optimal orientation of a runway and estimate the geometric design characteristics of an airport including taxiways, aprons and runways
- To learn pavement management systems and apply techniques for pavement strengthening/overlay design

**7.** Knowledge required

Preliminary Knowledge in Transportation Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| **CO No.** | **CO Statement** | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| 1 | *characterize* key aspects of airport design and operations | PO(a) | C2 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 2 | *describe* the main elements of an airport master plan | PO(a) PO(f) | C2 | Lectures, Class participation | Class test, final examination |
| 3 | *design* the optimal orientation of a runway (through wind rose analysis). | PO(c) | C2 | Lectures, Class participation | Class test, final examination |
| 4 | *estimate* the geometric design characteristics of an airport including taxiways, aprons and runways | PO(c) | C2 | Lectures, Class participation | Class test, final examination |
| 5 | *describe* special characteristics and requirements of airport and highway drainage | PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 6 | *analyze* pavement management systems and apply techniques for pavement strengthening/overlay design | PO(c) PO(g) | C4 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | ✓ | | | | | | | | | | | | | | | |
| CO-4 | | | | | ✓ | | | | | | | | | | | | | | | |
| CO-5 | | ✓ | | | | | | | | | | | | | | | | | | |
| CO-6 | | | | | | | ✓ | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Introduction of the course, Rationale, History, etc | Handout, Text Book | CO6 |
| Lecture 2 | Damages for faulty drainage, good drainage, Drainage and Geometric design | Handout, Text Book | CO5 |
| Lecture 3 | Surface drainage system | Handout, Text Book | CO5 |
| Lecture 4 | Design of Surface drainage system | Handout, Text Book | CO5 |
| Lecture 5 | Design of side ditches and other open channels | Handout, Text Book | CO6 |
| Lecture 6 | Culverts and Bridges | Handout, Text Book | CO6 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 7 | Highway Sub Surface drainage system | Handout, Text Book | CO6 |
| Lecture 8 | Drainage in Urban area & Class Test 1 | Handout, Text Book | CO6 |
| Lecture 9 | Airport Drainage | Handout, Text Book | CO6 |
| Lecture 10 | Highway maintenance | Handout, Text Book | CO6 |
| Lecture 11 | Pavement Management System | Handout, Text Book | CO6 |
| Lecture 12 | Strengthening of Pavements | Handout, Text Book | CO6 |
| Lecture 13 | Overlay of Airport Pavements | Handout, Text Book | CO6 |
| Lecture 14 | Overall discussion – Review of the course | | |
| Lecture 15 | Air Transportation Systems | Handout, Text Book | CO1 |
| Lecture 16 | Components of Air Transportation | Handout, Text Book | CO1 |
| Lecture 17 | Airport Planning | Handout, Text Book | CO2 |
| Lecture 18 | Airport Configuration | Handout, Text Book | CO2 |
| Lecture 19 | Analysis of wind and Site Selection Approach | Handout, Text Book | CO2 |
| Lecture 20 | Class Test 2 | Handout, Text Book | |
| Lecture 21 | Planning and Design of the Terminal Area | Handout, Text Book | CO2 |
| Lecture 22 | Air Traffic Control and Air Traffic Control Facilities | Handout, Text Book | CO3 |
| Lecture 23 | Air Traffic Control and Air Traffic Control Facilities (Contd.) | Handout, Text Book | CO3 |
| Lecture 24 | Airport Marking and Signage | Handout, Text Book | CO4 |
| Lecture 25 | Airport Marking and Signage (Contd.) | Handout, Text Book | CO4 |
| Lecture 26 | Airport Lighting | Handout, Text Book | CO4 |
| Lecture 27 | Air Safety & Regulation issues | Handout, Text Book | CO1 |
| Lecture 28 | Overall discussion – Review of the course | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| Item | Marks |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1.Planning and design of airports by R. Horonjeff
2.Highway Engineering by P. Wright

**14.** References

1. Airport Planning and Management by Seth B.Y. and A.T. Wells
2. Airport Management by C.D. Prather and R.N. Steele
3. Highway Engineering by Kadiali and Lal

## 20.55 Description of Course CE 457

**SECTION A: General Information**

**1.** Course Title **Transportation Engineering V: Urban Transportation Planning and Management**

**2.** Type of Course Transportation Engineering (Optional)

**3.** Offered to Civil Engineering

**4.** Pre-requisite Course(s) None

### SECTION B: Course Details

**5.** Course Content (As approved by the Academic Council)

The urban transport problems and trends; road network planning; characteristics and operation of different transit and paratransit modes, planning transit network; estimating system costs and benefits, pricing and financ4ing, evaluation, transit users attitude, policies and strategies for transit development in metropolitan cities; freight traffic planning and management; selected transport case studies, congestion management; safety management; environmental issues and sustainable transport.

**6.** Course Objectives

- To familiarize with the urban four step travel demand modelling process.
- To learn to analyze the urban road safety philosophy and examine the principles for creating safe road environment.
- To comprehend urban passenger and freight transport problems, trends and mitigation measures.
- Learn to carry out urban transport project evaluation process considering sustainability.

**7.** Knowledge required

Preliminary Knowledge in Transportation Engineering

**8.** Course Outcomes

At the end of the course a student should be able to

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | *Comprehend* the urban four step travel demand modelling process. | PO(a)<br>PO(b) | C2 | Lectures, Class participation | Class test, final examination |
| 2 | *Analyze* the urban road safety philosophy and examine the principles for creating safe road environment. | PO(a) | C4 | Lectures, Class participation | Class test, final examination |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 3 | *Comprehend* urban passenger and freight transport problems, trends and mitigation measures. | PO(a)<br>PO(c) | C2 | Lectures, Class participation | Class test, final examination |
| 4 | *Evaluate* urban transport project considering sustainability. | PO(b)<br>PO(g) | C6 | Lectures, Class participation | Class test, final examination |

*PO(a): Engineering knowledge; PO(b): Problem analysis; PO(c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| Cos | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-2 | | | ✓ | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | ✓ | | | | | | | | | | | | | | | |
| CO-4 | | | | | | | ✓ | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| Lecture 1 | Course Overview | Handout | —— |
| Lecture 2 | Transport Planning Data | Handout | CO-1 |
| Lecture 3 | Surveys Related to Urban Transportation Planning | Handout | CO-1 |
| Lecture 4 | Models in Planning | Handout | CO-1 |
| Lecture 5 | Trip Generation Model | Handout | CO-1 |
| Lecture 6 | Trip Distribution Model | Handout | CO-1 |
| Lecture 7 | Class Test 1 | | |
| Lecture 8 | Trip Distribution Model (Contd…) | Handout | CO-1 |
| Lecture 9 | Mode Choice Model | Handout | CO-1 |
| Lecture 10 | Traffic Assignment Model | Handout | CO-1 |
| Lecture 11 | Traffic Assignment Model (Contd…) | Handout | CO-1 |
| Lecture 12 | Sustainable Transportation System | Handout | CO-4 |
| Lecture 13 | Road Safety and Accident Studies | Handout | CO-2 |
| Lecture 14 | Road Safety and Accident Studies (Contd…) | Handout | CO-2 |
| Lecture 15 | Urban Transport Problems and Trends | Handout | CO-3 |
| Lecture 16 | Urban Transport Problems and Trends (Contd…) | Handout | CO-3 |
| Lecture 17 | Automobile Dependency: Trends, factors and Consequences | Handout | CO-3 |
| Lecture 18 | Urban Transport Development Paths | Handout | CO-3 |
| Lecture 19 | Urban Transport Development Paths (Contd…) | Handout | CO-3 |
| Lecture 20 | Urban Transit System and Challenge | Handout | CO-3 |
| Lecture 21 | Class Test 1 | | |
| Lecture 22 | Urban Transit System and Challenge (Contd…) | Handout | CO-3 |
| Lecture 23 | Urban Goods Movement: Characteristics, Issues and Problems | Handout | CO-3 |

| | | | |
|---|---|---|---|
| Lecture 24 | Urban Goods Movement: Characteristics, Issues and Problems (Contd…) | Handout | CO-3 |
| Lecture 25 | Congestion Types and Mitigation Measures | Handout | CO-3 |
| Lecture 26 | Class Test 2 | | |
| Lecture 27 | Evaluating Transportation Alternatives | Handout | CO-4 |
| Lecture 28 | Evaluating Transportation Alternatives (Contd…) | Handout | CO-4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Class Test: At least three class tests will be administered. Best two of them will be counted towards grading.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| **Item** | **Marks** |
|---|---|
| Attendance | 10% |
| Class Tests | 20% |
| Final Examination | 70% |

**13.** Textbook

1. Modelling Transport by Ortuzar, J. de Dios and L.G. Willumsen
2. Safer Roads: A Guide to Road Safety Engineering by K. W. Ogden

**14.** Reference

1. Urban Transportation Planning by M.D. Meyer and E. J. Miller

## 20.56 Description of Course Chem 103

## SECTION A: General Information

| | | |
|---|---|---|
| 1. | Course Number | Chem103 |
| | Course Title | Chemistry-I |
| | Credit Hours | 3 |
| | | |
| 2 | Level and Term | L1T1 |
| | Academic Term | Month Year (for example, Jan 2022) |
| | | |
| 3 | Type of Course | Chemistry |
| | Offered to | Department of Civil Engineering |
| | | |
| 4 | Pre-requisite Course(s) | N/A |
| 5 | Course Website | MS Teams |
| 6 | Lecture Schedule | As per the published routine |

| | | |
|---|---|---|
| 7 | Important Dates | For important dates and examination schedules and the latest updates, please follow the course website |

| | |
|---|---|
| 8 | Course Teachers |

| Name | Office | Email | Consultation Hour(s) |
|---|---|---|---|
| (Name of teacher 1) | Dept. of Chemistry | ------@chem.buet.ac.bd | Example: Saturday (10:00-10:50 am) - Location/Link |
| (Name of teacher 2) | Dept. of Chemistry | ------@chem.buet.ac.bd | Example: Saturday (10:00-10:50 am) - Location/Link |

## SECTION B: Course Details

| | |
|---|---|
| 9 | Course Content (As approved by the Academic Council) |
| | Atomic structure and quantum theory: Bohr's theory, Heisenberg's uncertainty principle, Schrödinger's wave equation, electronic configurations and properties of atoms. Electronic configurations and properties of molecules: chemical bond, valence bond theory, molecular orbital theory, shape of molecules, bond length, bond energy. Chemistry of halogens, alkali metals, alkaline earth metals, non-metals and heavy metals. Modern concepts of acids and bases. Different types of solutions. Properties of dilute solution. Thermo-chemistry. Electrochemistry: voltaic cells, electrolytic cells. Colloids and colloidal solution. Chemical and ionic equilibria. Chemistry of water; chemistry of water pollution. Chemistry of cements, silicates and limes. |

| | | |
|---|---|---|
| 10 | Course Objectives | |
| | Course objective 1 | To provide an in-depth understanding of the fundamentals of building components in atoms, molecules and thus matters, solution system, equilibrium and energetics of physico-chemical systems. |
| | Course objective 2 | To enable students building a foundation on underlying state-of-the-art scientific knowledge, and to develop critical thinking abilities for identifying, analyzing and resolving the issues they will encounter in their professional career. |

| | |
|---|---|
| 11 | Knowledge required |
| | N/A |

| | |
|---|---|
| 12 | Course Outcomes<br>**Course Outcomes (CO) and their mapping with Program outcomes (PO) and Teaching-Learning Assessment methods:** |

| | CO Statement<br>Upon successful completion of the course, students should be able to: | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| CO-1 | Identify fundamental concepts of atomic structure, chemical bonding, and geometry of molecules according to quantum theory | 1 | C1 | Lectures, Homework | Written exams, class test |
| CO-2 | Illustrate the basic principles associated with properties of atom/molecule, solution, chemical equilibria, colloids, and electrochemistry | 1 | C2 | Lectures, Homework, presentation | Written exams, class test |
| CO-3 | Solve problems associated with physico-chemical changes and environmental issues | 2 | C3 | Homework, lecture | Written exams, class test |
| CO-4 | Analyze the behavior of materials and examine environmental challenges with the concept of chemistry. | 3 | C4 | Lecture, presentation | Written exams, class test |

* PO1 Engineering knowledge, PO2 Problem analysis, PO3 Design/development of solutions, PO4 Investigation, PO5 Modern tool use, PO6 The engineer and society, PO7 Environment and sustainability, PO8 Ethics, PO9 Individual work and teamwork, PO10 Communication, PO11 Project management and finance, PO12 life-long learning

C-Cognitive: C1: Knowledge; C2: Understand; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

| | |
|---|---|
| 13 | Lecture Plan: Teacher-1 |

| | Lecture Topics | References | Corresponding CO(s) |
|---|---|---|---|
| L1 | Concepts of acids and bases | | CO1, CO2 |
| L2 | Theories of acid and base | | CO2 |
| L3 | Theories of acid and base | | CO3, CO4 |
| L4 | Different types of solutions | | CO2 |
| L5 | Colligative properties, vapor pressure lowering, elevation of boiling point | | CO2, CO3 |
| L6 | Depression of freezing point, Osmotic pressure, colligative properties of electrolytes | | CO2, CO3 |
| L7 | Properties of dilute solution for electrolytes | | CO2, CO4 |
| L8 | Basic concept of thermodynamics and thermochemistry | | CO2, CO3 |
| L9 | Laws of thermodynamics, heat capacity | | CO2, CO3 |
| L10 | Caloric value of fuel and food | | CO3, CO4 |
| L11 | Class Test-1 | | |
| L12 | Electrochemistry concepts | | CO2 |
| L13 | Electrochemistry: voltaic cells | | CO2, CO4 |
| L14 | Electrochemistry: electrolytic cells | | CO3, CO4 |
| L15 | Colloids and colloidal solution | | CO1, CO2 |
| L16 | Properties of colloids | | CO2, CO4 |
| L17 | Chemical and ionic equilibria | | CO2, CO3 |
| L18 | Chemical and ionic equilibria | | CO2, CO4 |
| L19 | Chemistry of water; chemistry of water pollution | | CO2 |
| L20 | Chemistry of cement, silicates and limes | | CO2 |
| L21 | Class Test-2 | | |

| 13 | Lecture Plan: Teacher-2 |
|---|---|

| | Lecture Topics | References | Corresponding CO(s) |
|---|---|---|---|
| L1 | General introduction and need of chemistry for engineering students | | - |
| L2 | Concepts of atomic structure, subatomic particles, atomic spectra, Bohr's Atomic model of hydrogen | | CO1, CO2 |
| L3 | Wave- particle duality of matter and energy: blackbody radiation and plank's quantum theory, photoelectric effect, dual nature of light | | CO1, CO4 |
| L4 | Broglie's matter wave, Dual nature of electron and Heisenberg uncertainty principle | | CO1, CO2 |
| L5 | Schrodinger wave equation, quantum numbers, Electron configuration of multielectron systems, effect of electronic configuration on atom's size, effective nuclear charge, | | CO1, CO4 |
| L6 | Periodic law, effective nuclear charge | | CO1, CO2 |
| L7 | Periodic variation of properties | | CO1, CO2 |
| L8 | Chemical bond and energies involved in the bond formation | | CO1, CO3 |
| L9 | Molecular structure | | CO2, CO3 |
| L10 | Quantum concepts of bonding | | CO3, CO4 |
| L11 | Class Test 1 | | |
| L12 | Bond length | | CO1, CO2 |
| L13 | Bond energy | | CO1, CO3 |
| L14 | Halogens Chemistry | | CO1, CO3 |
| L15 | Properties of Halogens | | CO1, CO4 |
| L16 | Alkali metals and properties | | CO1, CO4 |
| L17 | Chemical properties of alkali metals | | CO1, CO3 |
| L18 | Alkaline earth metals | | CO1, CO4 |
| L19 | Class test 2 | | |
| L20 | Non-metals | | CO1, CO2 |
| L21 | Heavy metals | | CO1, CO2 |

| 14 | Assessment Strategy |
|---|---|
| i | Class Participation: Class participation and attendance will be recorded in every class. |
| ii | Continuous Assessment: Continuous assessment of any of the activities such as quizzes, assignments, presentations, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes |
| iii | Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council. |

| 15 | Distribution of Marks | |
|---|---|---|
| | Class Participation | 10% |
| | Continuous Assessment | 20% |
| | Final Examination | 70% |
| | Total | 100% |

| 16 | Textbooks | |
|---|---|---|
| | Textbook-1 | Chemistry by Raymond Chang, Kenneth A. Goldsby |
| | Textbook-2 | General Chemistry by Ebbing, Darrell, Gammon, Steven D. |
| | Textbook-3 | Principles of Physical Chemistry by Kindle edition by Maron, S. H., Prutton, C.F. |
| | Textbook-4 | Chemistry: The Central Science (MasteringChemistry)<br>by Theodore Brown, H. LeMay, Bruce Bursten, Catherine Murphy, Patrick Woodward, Matthew Stoltzfus |

| 17 | References | |
|---|---|---|
| | Reference-1 | |
| | Reference-2 | |

| 18 | Weighting COs with Assessment methods |
|---|---|

| **Assessment Method** | **% Weight** | Mark distributions on COs and POs | | | |
|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 |
| | | PO1 | PO1 | PO2 | PO3 |
| Attendance | 10 | 2.5 | 2.5 | 2.5 | 2.5 |
| Continuous Assessment | 20 | | 10 | 10 | |
| Final | 70 | 10 | 30 | 20 | 10 |

**19. CO-PO mapping**

| Level/term | Course no | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L-1, T-1 | Chem 103 | ✓ CO1, CO2 | ✓ CO3 | ✓ CO4 | | | | | | | | | |

## 20.57 Description of Course Chem 114

## SECTION A: General Information

| | | |
|---|---|---|
| 1. | Course Number | Chem 114 |
| | Course Title | Inorganic Quantitative Analysis |
| | Credit Hours | 1.50 |
| | | |
| 2 | Level and Term | L1T1 |
| | Academic Term | Month Year (example; Jan 2022) |
| | | |
| 3 | Type of Course | Chemistry Sessional |
| | Offered to | Department of Civil Engineering |
| | | |
| 4 | Pre-requisite Course(s) | N/A |
| 5 | Course Website | MS Teams |

| | | |
|---|---|---|
| 6 | Lecture Schedule | As per the published routine |
| 7 | Important Dates | For important dates and examination schedules and latest updates, please follow the course website |

| | |
|---|---|
| 8 | Course Teachers |

| Name | Office | Email | Consultation Hour(s) |
|---|---|---|---|
| (Name of teacher 1) | Dept. of Chemistry | ------@chem.buet.ac.bd | Example: Saturday (10:00-10:50 am) - Location/Link |
| (Name of teacher 2) | Dept. of Chemistry | ------@chem.buet.ac.bd | Example: Saturday (10:00-10:50 am) - Location/Link |

## SECTION B: Course Details

| | |
|---|---|
| 9 | Course Content (As approved by the Academic Council) |
| | Volumetric analysis: Acidimetry-Alkalimetry. Titrations involving redox reactions: Determination of Fe, Cu, and Ca volumetrically. Determination of Ca and Mg in water. |

| | | |
|---|---|---|
| 10 | Course Objectives | |
| | Course objective-1 | To develop the basic understanding of a student dealing with chemical reagents, equipment necessary to perform quantitative inorganic analysis along with associated theoretical knowledge on acidimetry-alkalimetry, redox and complexometry |
| | Course objective-2 | To provide hands on experience on the techniques of volumetric methods in analyte determination and to prepare students presenting their experimental findings as scientific reports |

| | |
|---|---|
| 11 | Knowledge required |
| | N/A |

| | |
|---|---|
| 12 | Course Outcomes<br>**Course Outcomes (CO) and their mapping with Program outcomes (PO) and Teaching-Learning Assessment methods:** |

| | **CO Statement**<br>**Upon successful completion of the course, students should be able to:** | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity (-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| CO1 | Describe different parameters and techniques related to inorganic quantitative analysis | 1 | C1 | Lectures | Quiz, Class performanc, viva, Report writing |
| CO2 | Follow the instructions to perform guided enquiry in determining volume of titrants in different kinds of titrations | 4, 9 | P3 | Lectures and Demonstration | Quiz, Class performanc, viva, Report writing<br>Final Exam |

| | CO Statement Upon successful completion of the course, students should be able to: | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity (-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| CO3 | Analyze the experimental data for quantitative estimation of an analyte individually or by a group | 2, 9 | C4 | Lectures, Demonstration | Quiz, Class performanc, viva, Report writing Final Exam |
| CO4 | Prepare scientific reports on experiments by organizing experimental findings | 12 | C6 | Homework | Quiz, Class performanc, viva, Report writing, Final Exam |

* PO1 Engineering knowledge, PO2 Problem analysis, PO3 Design/development of solutions, PO4 Investigation, PO5 Modern tool use, PO6 The engineer and society, PO7 Environment and sustainability, PO8 Ethics, PO9 Individual work and teamwork, PO10 Communication, PO11 Project management and finance, PO12 life-long learning

C-Cognitive: C1: Knowledge; C2: Understand; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

| 13 | Lecture Plan: |
|---|---|

| | Lecture Topics | References | Corresponding CO(s) |
|---|---|---|---|
| L1 | Briefing on lab safety protocol and quiz on it | | CO1 |
| L2 | Course outline and introductory discussions on chemical analysis | | CO1 |
| L3 | Standardization of NaOH solution with standard oxalic acid solution | | CO1 - CO4 |
| L4 | Standardization of hydrochloric acid with standard NaOH solution | | CO1 - CO4 |
| L5 | Standardization of HCl with standard Na2CO3 solution | | CO1 - CO4 |
| L6 | Standardization of sodium thiosulphate solution with a standard potassium dichromate solution | | CO1 - CO4 |
| L7 | Estimation of copper contained in a supplied solution by iodometric method | | CO1 - CO4 |
| L8 | Determination of ferrous iron by a standard potassium dichromate solution | | CO1 - CO4 |
| L9 | Standardization of potassium permanganate solution with standard sodium oxalate solution | | CO1 - CO4 |
| L10 | Determination of ferrous ion in a solution by standard KMnO4 solution | | CO1 - CO4 |
| L11 | Determination of calcium in a sample of calcium carbonate | | CO1 - CO4 |
| L12 | Viva | | CO1, CO3 |
| L13 | Practical exam | | CO2, CO3 |
| L14 | Quiz | | CO1, CO3 |

| 14 | Assessment Strategy |
|---|---|
| i | Class Participation: Class participation and attendance will be recorded in every class. |

| | |
|---|---|
| ii | Continuous Assessment: Continuous assessment will be accomplished following any of the activities such as quizzes, report writing and viva. The scheme of the continuous assessment for the course will be declared on the first day of classes |
| iii | Final Examination: Practical examination will be held individually at the end of the sessional classes. |

| 15 | Distribution of Marks | |
|---|---|---|
| | Attendance and Class Performance | 20 |
| | Report | 30 |
| | Quiz | 40 |
| | Viva | 20 |
| | Final Examination | 40 |
| | Total | 150 |

| 16 | Textbooks | |
|---|---|---|
| | Textbook-1 | Quantitative Inorganic Analysis, By: A. I. Vogel |

| 17 | References | |
|---|---|---|
| | Reference-1 | |

| 18 | Weighting COs with Assessment methods |
|---|---|

| Assessment Method | Marks | Mark distributions on COs and POs | | | |
|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 |
| | | PO1 | PO4, 9 | PO 2, 9 | PO12 |
| Attendance and class performance | 20 | 5 | 10 | 5 | |
| Report | 30 | | | | 30 |
| Quiz | 40 | 30 | | 10 | |
| Viva | 20 | 20 | | | |
| Final Examination | 40 | | 20 | 20 | |

**CO-PO mapping of course offered**

| Level /term | Course no | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L-1, T-1 | Chem 114 | ✓ CO1 | ✓ CO3 | | ✓ CO2 | | | | | ✓ CO2 CO3 | | | ✓ CO4 |

## 20.58 Description of Course HUM 185

## Section A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | English |
| **2.** | Type of Course | Non-departmental, Theory, Compulsary |
| **3.** | Offered to | Department of Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## Section B: Course Details

**5.** Course Content (As approved by the Academic Council)

Introduction: Current approaches to learning English. English Phonetics: Phonetics & correct English pronunciation. English syntax: vocabulary, diction &English sentence; sentence variety & style; grammatical problems. Reading skill: Readability, reading strategies, generating ideas through purposivereading, reading of selected stories. Writing skill: Principles of effective writing; generating ideas, planning, organization and development of writing; composition, précis etc. Approaches to Communication: Communication today; Written Communication: Business communication, tenders and quotations, journal articles, report. OralCommunication: Dialogue, technical and scientific presentation

**6.** Course Objectives

- To address the specific needs of the students in strengthening their English language skills in reading, writing, speaking and listening
- To enhance their ability to understand and apply the principles of effective writing
- To prepare students to analyse literary texts critically

**7.** Knowledge required

None

**8.** Course Outcomes

| CO No. | CO Statement Upon completion of thecourse students will be able to | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | **Identify** the required communication skills in English for smooth navigation in the academic world and beyond | PO (10) | C1,C3 | Lectures, PPT Presentation | Assignment, Class Test and Term Final Exam |
| 2 | **Acquire** necessary skills for successful communication in English | PO(10) | C1, A1, A4 | Lectures, PPT Presentation | Assignment, Class Test and Term Final Exam |
| 3 | **Gain** confidence in listening, reading, speaking and writing English, functioning effectively as an individual and as a member of a team | PO(9) | C3,C5, A1, A4 | Lectures, PPT Presentation | Assignment, Class Test and Term Final Exam |
| 4 | **Analyse and evaluate** literary texts using appropriate critical methods, aiming at improvement of communication | PO(j), PO(8) | C4,C6, P1,P3 | Lectures, PPT Presentation | Assignment, Class Test and Term Final Exam |

| CO No. | CO Statement Upon completion of thecourse students will be able to | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 5 | **Demonstrate** competence in effective communication in English | PO(12) | C3, A4, A5, P6, P7 | Lectures, PPT Presentation | Assignment, Class Test and Term Final Exam |

*PO (1): Engineering knowledge; PO(2): Problem analysis; PO (3): Design/development of solutions; PO(4): Investigation; PO(5) Modern tool use; PO(6): The engineer and society; PO(7): Environment and sustainability; PO(8): Ethics; PO(9): Individual work and teamwork; PO(10): Communication; PO(11): Project management and finance; PO(12): life-long learning

**C -Cognitive: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation
A-Affective: **A1**: Receiving; **A2**: Responding; **A3**:Valuing; **A4**: Organizing; **A5**: Characterizing
P- Psychomotor: **P1**: Perception; **P2**: Set; **P3**:Guided Response; **P4**: Mechanism; **P5**: Complex Overt Response; **P6**: Adaptation; **P7**: Organization

## 9. Mapping of **Knowledge** Profile, Complex Engineering **Problem** Solving and Complex Engineering **Activities**

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-2 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-3 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-4 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-5 | | | | | | | ✓ | | | | | | | | | | | | | |

## 10. Lecture Plan

| Lec# | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1-3 | English Phonetics: Ways of correct English pronunciation,the speech sounds of English Language,differences and similarities between the speech sound of English and Bengali, the vowels, consonants and diphthongs, Phonetic transcription of some words | Baker (2008), Handout, Hornby (2020) | CO3, CO5 |
| 4-6 | Construction of sentences: Different types of sentences and their structure | Raymond (2001), Thomson & Martinet (2001), Handout | CO1, CO2 |
| 7-9 | Paragraph Writing: What is a paragraph? Topic sentence, connectives, order and unity in a paragraph<br><br>Evaluation (Class Test 1) | Imhoof & Herman (2000) Handout | CO5 |
| 10-12 | Grammatical Problems: Errors which usually occur in sentences, problems with different parts of speech with special reference to verbs, some problems in usage | Berry (2000) Fitikides (2002) | CO1, CO2, CO3, CO5 |

| Lec# | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 13-14 | Dialogue writing:What is a dialogue? Points that we need to keep in mind while writing dialogue on a given topic; Concept of effective oral presentation | Handout Sharma& Mohan (2000) | CO1, CO2, CO3, CO5 |
| 15-17 | Report Writing: Writing and Layout of a report, Different types of reports, Book Report; Science Project report; points that we should keep in mind while writing a science project report; writing reports on general topics | Sharma& Mohan (2000) | CO1, CO2, CO3, CO5 |
| 18 | Evaluation (Class Test 2) | | |
| 19 | Composition: Thesis sentence, organization, linking expressions, writing guided compositions following some hints, writing compositions on current affairs | Imhoof & Herman ( 2000) | CO1, CO2, CO3 |
| 20 | Comprehension: Reading imaginative and practical passages, meanings, styles, facts in given passages; points which we should keep in mind while doing exercise on comprehension, practicing reading comprehension | Simon& Swan (2001), Mosback, & Mosback (1999) | CO1, CO3, CO4, CO5 |
| 21 | Vocabulary: How can we enrich our collection of words? Getting meanings of unfamiliar words from their contexts, acquiring common words we need in our everyday life | McCarthy & O'Dell (2002), Handout | CO1, CO3, CO4, CO5 |
| 22 | Précis Writing: What is a précis? Which points we need to keep in mind while writing précis on a given passage? Writing précis on given passages | Sharma& Mohan (2000) | CO2, CO3, CO4, CO5 |
| 23-24 | General Strategies for the Writing Process:Generating Ideas, Identifying Audiences and Purposes, Constructive Arguments, Stating Problems, Drafting and Finalizing. Approaches to Communication, Specific Applications of: Tenders and Quotations, Resume and Job Letters, Journal Articles, Technical and Scientific Presentation.<br>Assignment (equivalent to One Class Test) | Sharma& Mohan (2000), Handout | CO1,CO2, CO3, CO5 |
| 25-26 | 'The Bet' by Anton Chekhov, Chekhov and his time; a general discussion of the story;<br>'The Diamond Necklace', by Guy-De-Maupassant, a general discussion of the story, a critical analysis of the story, important characters, themes, symbols | Choudhury & Haq (1982) | CO1,CO2, CO3,CO4,CO5 |
| 27 | 'The Garden Party' by Katherine Mansfield, a general discussion of the story, a comparative and critical analysis of the three stories | Siddiqui (1968) | CO1,CO2, CO3,CO4,CO5 |

| Lec# | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 28 | Feedback Session: A general discussion on the topics already covered | | CO5 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of Academic Council.

**12.** Distribution of Marks

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**13.** Textbooks/References

- Imhoof, M., & Herman, H. From Paragraph to Essay. Harlow: Longman, 2000.
- Berry, T.E. *TheMost Common Mistakes in English Usage.* New Delhi: McGraw-Hill, 2000.
- Fitikides, T.J. *Common Mistakes in English.* London: Longman, 2002.
- Sharma, R C., & Mohan, Krishna. *Commercial Correspondence and Report Writing.* New Delhi: Tata McGraw-Hill, 2000
- G, Simon., & Swan, M. *Effective Reading.* Cambridge: CUP, 2001
- Mosback, G., & Mosback, V. *Practicing Faster Reading.* Cambridge: CUP, 1999
- Choudhury, Serajul Islam and Haq, Ahsanul. Ed. *Prose of Our Time*.Dhaka: Nawroze Kitabistan, 1982
- Siddiqui, M.Naimuddin.*A Selection of Short Stories*. London:MacMillan, 1968
- Raymond, Murphy. *Intermediate English Grammar.* Cambridge: CUP
- ---. *Essential Grammar in Use.* Cambridge: CUP, 2001
- Thomson, A. J., & Martinet, A.V. *A Practical English Grammar.* New Delhi: OUP, 2001
- McCarthy , Michael & O'Dell, Felicity.*English Vocabulary in Use*. Cambridge: CUP,2002

**Important University Policies:**

- Rules and regulations for the undergraduate programmes: https://www.buet.ac.bd/info/Academicinformation/RulesUndergradprogram

**Important Departmental/Course Policies**

- Program Outcomes: Link to program outcomes

**CO-Po mapping for all offered courses:**

Complete this table with tick mark (). If required add/delete columns or rows

| Level and Term | Course Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level 1 Term 2 | English | | | | | | | | ✓ | ✓ | ✓ | | ✓ |

## 20.59 Description of Course HUM 217

## Section A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | Engineering Economics |
| **2.** | Type of Course | Compulsory, Theory, Non-departmental |
| **3.** | Offered to | Department of Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

## Section B: Course Details

**5.** Course Content (As approved by the Academic Council)

Economics and engineering; microeconomics and macroeconomics; theory of demand and supply and their elasticities; demand estimation; price determination; indifference curve technique; theory of production; theory of cost and cost estimation; market structure; national income accounting, depreciation; circular flow of income and expenditure; cost-benefit analysis; payback period, net present value (NPV), internal rate of return (IRR), inflation; economic feasibility of engineering undertakings

**6.** Course Objectives

This course has been designed for undergraduate students

- To give a clear idea about the fundamental economic problems and provide adequate knowledge for understanding basic economic theories and practices, and their implications in an economy.
- To provide students an understanding of how the modern economy functions in the real world and thereby prepare them to evaluate the state-of-affairs of an economy using an economist's lenses.
- To make students enable to apply their acquired knowledge in different stages of their professional career.

**7.** Knowledge required

Not Applicable

**8.** Course Outcomes

| **CO No.** | *At the end of the course, and having completed the essential readings and activities, students would be able to:* | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| CO1 | **understand** the nature of the discipline, economics science, and how it deals with the issues related to scarcity of resources | PO(i) | C1. C2;<br>A1;<br>P1 | Lectures; power point presentations; Home work | Class test; assignment; final exam |
| CO2 | **describe** consumer behaviour with reference to utility analysis, market mechanism through interactions between demand and supply analysis, and their elasticities | PO(9) | C2;<br>A1;<br>P1 | Lectures; power point presentations; Home work | Class test; assignment; final exam |

| CO No. | *At the end of the course, and having completed the essential readings and activities, students would be able to:* | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| CO3 | **Explain** the situation of a firm with reference to factors of production, determinants of cost, economies, and diseconomies of scale of production, conditions for profit maximization and so on | PO(9) | C2; P4 | Lectures; power point presentations; Group Discussion; Home work | Class test; extempore test; assignment; final exam |
| CO4 | **analyse** the performance of firms under different market structures | PO(9) | C2; A3 | Lectures; power point presentations; Group discussion;Home work | Class test; extempore test; assignment; final exam |
| CO5 | **evaluate** important economic events and statistics, and, more importantly, know what determines them | PO(9) | C2; C6 A4 | Lectures; power point presentations; Home work | Class test; assignment; final exam |
| CO6 | **understand** the core concepts of macroeconomics, e.g., aggregate demand, aggregate supply, national income accounting, circular flow of income and expenditure, savings and investment, inflation, and money | PO(9) | C1. C2; P1 | Lectures; power point presentations; Home work | Class test; assignment; final exam |
| CO7 | **synthesise** the implications of different economic policies like fiscal policy, monetary policy and trade policy with reference to Bangladesh | PO(9), PO(7) | C3, C4, C5; A3; P5 | Lectures; power point presentations; Home work | Class test; assignment; final exam |
| CO8 | **conceive and compare** different techniques and tools for economic evaluation of engineering undertakings and related projects | PO(7), PO (11), PO (12) | C3;C4.C5 A3, A4; A5 P5. P7 | Lectures; power point presentations; Group Discussion; Home work | Class test; extempore test; assignment; final exam |
| CO9 | **illustrate** the nature of an economic theory and the applicability of economic theories to the problems of developing countries | PO(7), PO(9), PO(11), PO(12) | C5; A4, A5; P7 | Lectures; power point presentations; Group discussion;Home work | Class test; extempore test; assignment; final exam |

*PO (1): Engineering knowledge; PO(2): Problem analysis; PO (3): Design/development of solutions; PO(4): Investigation; PO(5) Modern tool use; PO(6): The engineer and society; PO(7): Environment and sustainability; PO(8): Ethics; PO(9): Individual work and teamwork; PO(10): Communication; PO(11): Project management and finance; PO(12): life-long learning

**C -Cognitive: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation
A-Affective: **A1**: Receiving; **A2**: Responding; **A3**:Valuing; **A4**: Organizing; **A5**: Characterizing
P- Psychomotor: **P1**: Perception; **P2**: Set; **P3**:Guided Response; **P4**: Mechanism; **P5**: Complex Overt Response; **P6**: Adaptation; **P7**: Organization

**9.** Mapping of **Knowledge** Profile, Complex Engineering **Problem** Solving and Complex Engineering **Activities**

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | | | | | | | | | | | | | | |
| CO-2 | | | | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | | | | | | | | | | | | | | | | |
| CO-5 | | | | | | | | | | | | | | | | | | | | |
| CO-6 | | | | | | | | | | | | | | | | | | | | |
| CO-7 | | | | | | | | | | | | | | | | | | | | |
| CO-8 | | | | | | | | | | | | | | | | | | | | |
| CO-9 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

**10.** Lecture Plan

| **Class No.** | **Topics** | **References** | **Corresponding CO(s)** |
|---|---|---|---|
| 1-2 | Definition of Economics. Economics and Engineering. Principles of Economics | Hubbard, G. & O'Brien, A. P. (2021a), Salvatore, D (2008), Sloman et.al., (2018) | **CO1** |
| 3-4 | microeconomics: consumer behaviour, theory of demand and supply and their elasticity | Hubbard, G. & O'Brien, A. P. (2021a); Salvatore, D (2008), Sloman et.al., (2018), Koutsoyannin, A (1975). | **CO2** |
| 5-6 | price determination; indifference curve technique | Hubbard, G. & O'Brien, A. P. (2021a); Salvatore, D (2008), Sloman et.al., (2018) | **CO2** |
| 7-8 | factors of production; marginal analysis and optimization | Hubbard, G. & O'Brien, A. P. (2021a); Salvatore, D (2008), Sloman et.al., (2018) | **CO2** |
| 9-10 | theory of production; theory of costs | Hubbard, G. & O'Brien, A. P. (2021a); Salvatore, D (2008), Sloman et.al., (2018). | **CO3** |
| 11-12 | market structure. optimization | Hubbard, G. & O'Brien, A. P. (2021a); Salvatore, D (2008), Sloman et.al., (2018) | **CO4** |
| 13-14 | internal and external economies and diseconomies | Hubbard, G. & O'Brien, A. P. (2021a) | **CO3, CO4** |
| 15-16 | Macroeconomics: major macroeconomic policy issues, national income analysis | Hubbard, G. & O'Brien, A. P. (2021b); Diulio, E (1997), Sloman et.al., (2018); Dornbusch, R., Fischer, S.andStartz, R. (2011) | **CO5** |
| 17-18 | aggregate demand and aggregate supply | Hubbard, G. & O'Brien, A. P. (2021b);Diulio, E (1997), Sloman et.al., (2018); Mankiw N.G (2007) | **CO6** |

| | | | |
|---|---|---|---|
| 19-20 | savings and investment; circular flow of income and expenditure; inflation; money; Internal and external economies and diseconomies | Hubbard, G. & O'Brien, A. P. (2021b);Diulio, E (1997), Sloman et.al., (2018); Mankiw N.G (2007). | **CO6** |
| 21-22 | monetary policy, fiscal policy, and trade policy with reference to Bangladesh | Hubbard, G. & O'Brien A. P. (2021b);Dornbusch, R., Fischer, S.andStartz, R. (2011). | **CO7** |
| 23-24 | Cost-benefit analysis; Economic and financial CBA; payback period; Net present value (NPV) | Hubbard, G. & O'Brien A. P. (2021b); Dornbusch, R., Fischer, S.andStartz, R. (2011) | **CO8** |
| 25-26 | Internal rate of return (IRR); Economic feasibility of engineering undertakings | Hubbard, G. & O'Brien A. P. (2021b);Sloman et.al., (2018); Mankiw N.G (2007) | **CO8** |
| 27-28 | nature of an economic theory and the applicability of economic theories to the problems of developing countries | Todaro, M. P. (2020), Hubbard, G. & O'Brien, A. P. (2021b);Diulio, E (1997), Sloman et.al., (2018); Mankiw N.G (2007) | **CO9** |

## **11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

## **12.** Distribution of Marks

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

## **13.** Textbooks/References

Textbook:


- Hubbard, G. & O'Brien, A. P. (2020a). *Microeconomics*. Pearson. 8th Edition, https://www.pearson.com/en-us/subject-catalog/p/microeconomics/P200000005936?view=educator

- Hubbard, G. & O'Brien, A. P. (2021b). *Macroeconomics*. Pearson. 8th Edition, https://www.pearson.com/en-us/subject-catalog/p/macroeconomics/P200000005935/9780136713791.

- Sloman, J., Garratt, D. and Guest, J. (2018). *Economics*. Pearson.


References:


- Hubbard, G. & O'Brien, A. P. (2021c). *Economics*. Pearson. 8th Edition, https://www.pearson.com/en-us/subject-catalog/p/economics/P200000005930/9780136713951.
- Salvatore, D. (2008). *Microeconomics: theory and applications*. McGraw-Hill.
- Koutsoyiannis, A. (1975). *Modern Microeconomics*. Springer.
- Mankiw, N. G. (2007). *Principles of Microeconomics*.

- Mankiw, N.G. (2020). *Principles of Macroeconomics*. Cengage Learning.
- Dornbusch, R., Fischer, S. and Startz, R. (2011). *Macroeconomics*. McGraw-Hill.
- Diulio, E. (1997). *Macroeconomics: theory and problems*. McGraw-Hill.
- Todaro, M. P. (2021). *Economic Development*, 13th Edition, https://www.pearson.com/us/higher-education/program/Todaro-Economic-Development-13th-Edition/PGM100003100761.html.

## 20.60 Description of Course HUM 274

**Section A: General Information**

| | | |
|---|---|---|
| **1.** | Course Title | Developing English Skills (Sessional) |
| **2.** | Type of Course | Non-Departmental Sessional, Compulsory |
| **3.** | Offered to | Department of Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

**Section B: Course Details**

**5.** Course Content (As approved by the Academic Council)

**Reading skill**: Skimming, scanning, predicting, inferring; Analysis and interpretation of texts; Comprehension from literary and non-literary texts.

**Writing skill**: Current approach to writing: Process and product; i) brain storming, ii) self-evaluation, iii) peer evaluation, iv) revision/rewriting, v) teacher's evaluation; Techniques of writing: i) comparison and contrast, ii) problem and solution, iii) cause and effect, iv) classification, v) illustration; Writing paragraph, essay and report.

**Listening skill**: Listening to recorded texts, learning to take useful notes and answering questions.

**Speaking skill**: Dialogue in peer work; Participation in discussion and debate; Extempore speech; Narrating events; Story telling; Presentation.

**6.** Course Objectives

- To enable learners to communicate effectively in academic and professional settings by developing their four core communication skills in English: listening, speaking, reading, and writing
- To develop an appreciation for English literary texts among learners to improve their English language skills

**7.** Knowledge required

None

**8.** Course Outcomes

| **CO No.** | **CO Statement**<br><br>*Upon successful completion of this course, learners will be able to* | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)**** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| CO1 | **express** ideas and opinions fluently in English in social and professional settings | PO(9); PO(10) | C2 | Lectures;<br>Extempore speech;<br>Q & A Forums | Viva voce;<br>Presentation;<br>Debate |

| CO No. | CO Statement<br><br>*Upon successful completion of this course, learners will be able to* | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| CO2 | **follow** speech, lectures, and arguments in common English accent | PO(10) | A1, A3;<br>P3 | Lectures;<br>Listening practice;<br>Q & A Forums | Viva voce;<br>Presentation;<br>Debate;<br>Phonetics test |
| CO3 | **understand** and **analyse** English literary texts and articles with ease | PO(10) | C4, C2 | Lectures; Group discussion on short stories and essay;<br>Q & A Forums | Written exams;<br>Viva voce; Debate |
| CO4 | **organize** and **synthesize** ideas in a clear, detailed, and well-structured text | PO(10) | C5, A4 | Lectures;<br>Writing practice in peer groups;<br>Corrective feedback on writing;<br>Q & A Forums | Written exams;<br>Assignment on presentation synopsis,<br>Report |
| CO5 | **compose** paragraphs, reports, and essays on complex subjects | PO(10) | C6;<br>P7 | Lectures;<br>Writing paragraphs, essays, and reports in peer group,<br>Q & A Forums | Written exams;<br>Report |

*PO (1): Engineering knowledge; PO(2): Problem analysis; PO (3): Design/development of solutions; PO(4): Investigation; PO(5) Modern tool use; PO(6): The engineer and society; PO(7): Environment and sustainability; PO(8): Ethics; PO(9): Individual work and teamwork; PO(10): Communication; PO(11): Project management and finance; PO(12): life-long learning
**C -Cognitive: C1 – Knowledge, C2 – Comprehension, C3 – Application, C4 – Analysis, C5 – Synthesis, C6 – Evaluation
A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
P- Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-2 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-3 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-4 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-5 | | | | | | | ✓ | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1 | Introduction to General English<br>Listening Practice<br>Extempore Speech | Sharma & Mohan, 2000<br>Baker, 2008 | CO1, CO2 |
| 2 | Listening Practice<br>Picture Description | Handout<br>Baker, 2008 | CO1, CO2 |
| 3 | Listening Practice<br>Dialogue: Practice in Pair Work | Sharma & Mohan, 2000<br>Baker, 2008 | CO1, CO2 |
| 4 | Introduction to Paragraph<br>Writing Paragraph in Peer Group | Imhoof & Herman, 2000<br>Hefferman, 2001 | CO4, CO5 |
| 5 | Report: Types & Layout<br>Assignment on Report<br>Selection of the Report Topic | Sharma & Mohan, 2000 | CO4, CO5 |
| 6 | English Phonetics: A Gateway to Correct English Pronunciation<br>Phonetic Symbols & Their Applications, Phonetic Transcriptions<br>Listening Practice<br>Discussion on Short Stories<br>Instruction for Selecting Topic of Presentation | Baker, 2008<br>Handout<br>Sharma & Mohan, 2000 | CO2, CO3 |
| 7 | Test on Phonetics<br>Listening Practice<br>Submission of Topic for Mock & Final Presentation<br>Discussion on Short Stories | Baker, 2008<br>Handout | CO2, CO3 |
| 8 | Debate Based on Short Stories | - | CO1 |
| 9 | Mock Presentation | - | CO1 |
| 10 & 11 | Final Test on Presentation<br>Submission of the Presentation Synopsis | - | CO1, CO4 |
| 12 | Final Test on Reading & Writing Skills | - | CO3, CO4, CO5 |
| 13 & 14 | Final Test on Speaking Skill | - | CO1, CO2 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive reading and writing skills test will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

Class Participation 10%
Continuous Assessment 56.67%
(Test on phonetics, Presentation synopsis, Report, Final presentation, Speaking skill test)
Final Examination 33.33%
(Reading and writing skill test)
Total 100%

**13.** Textbook/References

1. Textbook:
2. Reference:

- Sharma, R C., & Mohan, Krishna. *Commercial Correspondence and Report Writing*. New Delhi: Tata McGraw-Hill, 2000.
- Baker, Ann. *Ship or Sheep?* New Delhi: Cambridge University Press, 2008.
- G, Simon., & Swan, M. *Effective Reading.* Cambridge: CUP, 2001.
- Mosback, G., & Mosback, V. *Practicing Faster Reading.* Cambridge: CUP, 1999.
- Imhoof, M., & Herman, H. *From Paragraph to Essay.* Harlow: Longman, 2000.
- Thomson, A. J., & Martinet, A.V. *A Practical English Grammar.* New Delhi: OUP, 2001.
- Hefferman, AW James. *Writing: A College Handbook*. London: Norton, 2001.
- Fitikides, T.J. *Common Mistakes in English.* London: Longman, 2002.

**14.** Important University Policies:

- Rules and regulations for the undergraduate programmes:
  https://www.buet.ac.bd/info/Academicinformation/RulesUndergradprogram

**15.** Important Departmental/Course Policies

- Program Outcomes: Link to program outcomes
- Learning Domains: Link to learning domains documents

## 20.61 Description of Course HUM 353

## Section A: General Information

1. **Course Title** Accounting
2. **Type of Course** Non-departmental, Theory, Compulsory
3. **Offered to** Civil Engineering (CE)
4. **Pre-requisite Course(s)** None

## Section B: Course Details

5. Course Content (As approved by the Academic Council)
   Financial Accounting: Objectives and importance of Accounting; Accounting as an information system; Basic accounting principles; Accounting equation; Recording system; Accounting cycle; Journal, Ledger, Trial Balance; Preparation of Financial statements considering adjusting entries; Financial statement analysis and interpretation.
   Cost Accounting: Cost concepts and classification; Cost-volume-profit analysis; Contribution margin approach and its application, Break-even analysis, Target profit analysis, Operating leverage; Absorption costing vs Variable costing; Job order costing; Capital budgeting; Long run planning and control.

6. Course Objectives

- to make students conversant about the basic concepts of financial, cost, and managerial accounting
- to demonstrate students different accounting methodologies, procedures, tools, and techniques
- to enable students preparing, analysing, and interpreting financial, cost and managerial information and taking appropriate decisions

7. Knowledge required
   Not Applicable

8. Course Outcomes

| CO No. | CO Statement Upon successful completion of the course the students should be able to | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| CO1 | **express** the basic concepts of financial, cost and managerial accounting | PO(9) | C2, A1, P1, P2 | Lectures, Powerpoint presentation | Class tests; Assignments; Quiz; Final Exam |
| CO2 | **identify** and **classify** different cost, managerial and financial information of any organization | PO(9), PO(8) | C1, C4, A2, P3 | Lectures, Powerpoint presentation | Class tests; Assignments; Quiz; Final Exam |
| CO3 | **illustrate** financial information and analyse financial performance and position of an entity | PO(7), PO(8), PO(9) , PO(12) | C3, C4, A3, A4, P3, P4 | Lectures, Powerpoint presentation | Class tests; Assignments; Quiz; Final Exam |
| CO4 | **facilitate** and **justify** different financial and investment decisions | PO(11), PO(12) | C5, C6, A4, A5 | Lectures, Powerpoint presentation | Class tests; Assignments; Quiz; Final Exam |
| CO5 | **demonstrate** different costing and managerial methods and techniques | PO(9) | C3, A1, A2, P1, P2 | Lectures, Powerpoint presentation | Class tests; Assignments; Quiz; Final Exam |

| | | | | | |
|---|---|---|---|---|---|
| CO6 | **plan** effective costing tools and techniques for cost-benefit analysis | PO(11), PO(12) | C5, A3, P3, P4 | Lectures, Powerpoint presentation | Class tests; Assignments; Quiz; Final Exam |
| CO7 | **evaluate** projects for benefit maximization. | PO(11), PO(12) | C6, A4, P5 | Lectures, Powerpoint presentation | Class tests; Assignments; Quiz; Final Exam |

*PO (1): Engineering knowledge; PO(2): Problem analysis; PO (3): Design/development of solutions; PO(4): Investigation; PO(5) Modern tool use; PO(6): The engineer and society; PO(7): Environment and sustainability; PO(8): Ethics; PO(9): Individual work and teamwork; PO(10): Communication; PO(11): Project management and finance; PO(12): life-long learning

**C -Cognitive: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation. A-Affective: **A1**: Receiving; **A2**: Responding; **A3**:Valuing; **A4**: Organizing; **A5**: Characterizing. P-Psychomotor: **P1**: Perception; **P2**: Set; **P3**:Guided Response; **P4**: Mechanism; **P5**: Complex Overt Response; **P6**: Adaptation; **P7**: Organization

## 9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | | | | | | | | | | | | | | |
| CO-2 | | | | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | | | K7 | | | | | | | | | | | | | |
| CO-4 | | | | | | | K7 | | | | | | | | | | | | | |
| CO-5 | | | | | | | | | | | | | | | | | | | | |
| CO-6 | | | | | | | K7 | | | | | | | | | | | | | |
| CO-7 | | | | | | | K7 | | | | | | | | | | | | | |

## 10. Lecture Plan

| **Lectures** | **Topics** | **References** | **Corresponding CO(s)** |
|---|---|---|---|
| 1-2 | Introduction to Financial Accounting; Introduction to Cost Accounting | Kieso(12th Ed.) & Garrison (14th Ed.) | CO1 |
| 3-4 | Assumptions and Principles; Cost Concepts and Classification | Kieso(12th Ed.) & Garrison (14th Ed.) | CO1, CO2 |
| 5-6 | Accounting as an information system, accounting cycle, Accounting equation; Cost Concepts and Classification | Kieso(12th Ed.) & Garrison (14th Ed.) | CO1, CO2 |
| 7-8 | Transaction Analysis; Cost Sheet: Cost of Goods Manufactured, Cost of Goods Sold and Income Statement; | Kieso(12th Ed.) & Garrison (14th Ed.) | CO2, CO5 |
| 9-10 | Recording Process; Absorption costing vs Variable costing | Kieso(12th Ed.) & Garrison (14th Ed.) | CO2, CO5 |
| 11-12 | Recording Process; Absorption costing vs Variable costing | Kieso(12th Ed.) & Garrison (14th Ed.) | CO2, CO5 |

| Lectures | Topics | References | Correspon ding CO(s) |
|---|---|---|---|
| 13-14 | Adjusting the Accounts; Cost Volume Profit Analysis | Kieso(12th Ed.) & Garrison (14th Ed.) | CO2, CO5, CO6 |
| 15-16 | Adjusting the Accounts; Cost Volume Profit Analysis | Kieso(12th Ed.) & Garrison (14th Ed.) | CO2, CO5, CO6 |
| 17-18 | Preparation of Financial Statements or Reports; Cost Volume Profit Analysis | Kieso(12th Ed.) & Garrison (14th Ed.) | CO3, CO5 |
| 19-20 | Preparation of Financial Statements or Reports; Job order costing | Kieso(12th Ed.) & Garrison (14th Ed.) | CO3, CO5 |
| 21-22 | Preparation of Financial Statements or Reports; Job order costing | Kieso(12th Ed.) & Garrison (14th Ed.) | CO3, CO5 |
| 23-24 | Financial Statements/ Report analyse and Interpretation; Long run planning and control, Capital Budgeting | Kieso(12th Ed.) & Garrison (14th Ed.) | CO4, CO5, CO6, CO7 |
| 25-26 | Financial Statements/ Report analyse and Interpretation; Capital Budgeting | Kieso(12th Ed.) & Garrison (14th Ed.) | CO4, CO5, CO6, CO7 |
| 27-28 | Course Review | | |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**13.** Textbook/References

- Accounting Principles, 12th Edition, Jerry J. Weygandt, Paul D. Kimmel, Donald E. Kieso.
- Managerial Accounting, 14th Edition, Ray Garrison, Eric Moreen, Peter Brewer.
- Cost Accounting: A Managerial Emphasis, 8th Edition, Charles T. Horngren, George Foster, Srikant M. Datar.

## Important University Policies:

- Rules and regulations for the undergraduate programmes: https://www.buet.ac.bd/info/Academicinformation/RulesUndergradprogram

## Important Departmental/Course Policies

- Program Outcomes: Link to program outcomes

## CO-Po mapping for all offered courses:

Complete this table with tick mark (✓). If required add/delete columns or rows

| Level and Term | Course Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level-2 Term-I | Accounting | | | | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |

## 20.62 Description of Course HUM 355

## Section A: General Information

1. **1.** Course Title — Sociology
2. **2.** Type of Course — Non-departmental, Theory, Optional
3. **3.** Offered to — Civil Engineering
4. **4.** Pre-requisite Course(s) — None

## Section B: Course Details

**5.** Course Content (As approved by the Academic Council)

Nature, scope and perspectives of sociology; stages of social research and research methods; culture and civilization; socialization and personality development; globalization; media and individual; social organization and social problem; social stratification; industrial revolution, capitalism and socialism; work and economic life; environment and human activities; climate change and global risk; population and human society; urbanization and city development; social change and technology.

**6.** Course Objectives

- to make students familiar with the basic concepts of society, community, and culture
- to prepare students perceive the notion of social organization, social stratification, modernization, and globalization in a pragmatic fashion
- to equip students with necessary social skills which will assist them in their future careers

**7.** Knowledge required

None

**8.** Course Outcomes

| CO No. | CO Statement *Upon the completion of the course the students should be able to* | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | ***define*** sociological imagination | PO(10) | C1<br>A1<br>P1 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 2 | ***compare*** sociology and other social sciences | PO (12) | C2<br>A1<br>P1 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |

| CO No. | CO Statement<br>*Upon the completion of the course the students should be able to* | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 3 | ***solve*** social problems by applying sociological investigation | PO (9), PO (11), PO (12) | C6<br>A3<br>P3 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 4 | ***illustrate*** human society, culture, social stratification, and social mobility | PO(8), PO(12) | C2<br>A2<br>P2 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 5 | ***explain*** socialization, and social organization | PO(8), PO(9) | C2<br>A2<br>P1 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 6 | ***distinguish*** crime, deviance, and juvenile delinquency | PO(8), PO(12) | C4<br>A4<br>P2 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 7 | ***debate*** on industrial revolution, capitalism, and globalization | PO(8), PO(9) | C4<br>A4<br>P2 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 8 | ***define*** demographic variables | PO(10), PO(12) | C1<br>A1<br>P1 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 9 | ***recall*** the growth of cities from sociological point of view | PO(11), PO(12) | C1<br>A1<br>P1 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |
| 10 | ***interpret***, environment, climate, and social change | PO(7) | C3<br>A2<br>P3 | Lectures, Group Discussion, Homework | Assignment, Quiz, Presentation, Class Test, Term Final Exam. |

*PO (1): Engineering knowledge; PO(2): Problem analysis; PO (3): Design/development of solutions; PO(4): Investigation; PO(5) Modern tool use; PO(6): The engineer and society; PO(7): Environment and sustainability; PO(8): Ethics; PO(9): Individual work and teamwork; PO(10): Communication; PO(11): Project management and finance; PO(12): life-long learning

**C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | | | | | | | | | | | | | | |
| CO-2 | | | | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-4 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-5 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-6 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-7 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-8 | | | | | | | | | | | | | | | | | | | | |
| CO-9 | | | | | | | | | | | | | | | | | | | | |
| CO-10 | | | | | | | ✓ | | | | | | | | | | | | | |

**10.** Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1–2 | Introduction to sociology, developing sociological imagination, sociology and other social sciences | Schaefer, R.T. (2018) , Mills, C. W. (2000) | CO1, CO2 |
| 3–4 | Sociological research: Methods and procedures | Schaefer, R.T. (2018) | CO3 |
| 5–6 | Social stratification and social mobility | Schaefer, R.T. (2018) , Macionis, J.J. (2008) | CO4 |
| 7–8 | Culture and human society | Schaefer, R.T. (2018), Macionis, J.J. (2008) | CO4 |
| 9–10 | Socialization and social organization | Macionis, J.J. (2008), Giddens, A. (2009) | CO5 |
| 11–12 | Deviance, crime, and juvenile delinquency | Schaefer, R.T. (2018) | CO6 |
| 13–14 | Industrial revolution | Schaefer, R.T. (2018), Giddens, A. (2009) | CO7 |
| 15–16 | Globalization and modern life | Giddens, A. (2009) | CO7 |
| 17–18 | Population and society | Schaefer, R.T. (2018) | CO8 |
| 19–20 | Demography, and human migration | Schaefer, R.T. (2018) | CO8 |
| 21–22 | Urbanization and urbanism: the growth of cities. | Schaefer, R.T. (2018) | CO9 |
| 23–24 | Human society, environment | Macionis, J.J. (2008) | CO10 |
| 25–26 | Technology and social change | Macionis, J.J. (2008) | CO10 |
| 27–28 | Development of capitalism and social inequality | Schaefer, R.T. (2018), Giddens, A. (2009) | CO7, CO4 |

**11.** Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**12.** Distribution of Marks

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**13.** Textbook/References

3. Richard T. Schaefer, 'Sociology: A Brief Introduction', 13th Edition, McGraw-Hill Education, New York, USA (2018).
4. Anthony Giddens, 'Sociology', 6th Edition, Polity Press, UK (2009).
5. Mills, C. W. (2000). The Sociological Imagination (40th ed.). New York: Oxford University Press. (Original work published 1959).
6. Macionis, J.J. (2008). Sociology: A Global Introduction (4th ed.). London: Pearson Education.

## 20.63 Description of Course HUM 375

### Section A: General Information

| | | |
|---|---|---|
| **1.** | Course Title | Government |
| **2.** | Type of Course | Optional, Theory, Non-departmental |
| **3.** | Offered to | Department of Civil Engineering |
| **4.** | Pre-requisite Course(s) | None |

### Section B: Course Details

**5.** Course Content (As approved by the Academic Council)

Basic Concepts of Government and Politics: forms of government; organs of government- legislature, executive, judiciary; functions of government; democracy; socialism; welfare state; bureaucracy; good governance; e-government.

Government and Politics of Bangladesh: major administrative reforms; major amendments to the constitution- non-party caretaker government; local government; public policies; non-government organizations (NGOs); managing development project- planning, implementation, monitoring and evaluation; constitutional bodies- election commission, comptroller and auditor general, public service commission; foreign policy of Bangladesh.

Regional and International Organizations: SAARC, ASEAN, UNO

**6.** Course Objectives

This course has been designed for undergraduate students

1. to develop understanding on political institutions and processes including state, citizen, rights, forms and organs of government, bureaucracy, and governance
2. to provide knowledge on the government and politics of Bangladesh
3. To enhance understanding on selected international organizations which will make them responsible global citizen

**7.** Knowledge required

Not Applicable

**8.** Course Outcomes

| **CO No.** | **CO Statement** *At the end of the course, and having completed the essential readings and activities, students would be able to:* | **Corresponding PO(s)*** | **Domains and Taxonomy level(s)** | **Delivery Method(s) and Activity(-ies)** | **Assessment Tool(s)** |
|---|---|---|---|---|---|
| CO1 | **understand** the political institutions and processes including state, forms and organs of government | PO(6) | C1, C2; P1 | Lectures; power point presentations; Home work | Class test; assignment; final exam |
| CO2 | **achieve** basic knowledge on accountability, rule of law and other institutional arrangements of a state and **understand** the role of national and international actors | PO(6); PO(9); PO(10) | C1, C2; A3 | Lectures; power point presentations; Home work | Class test; assignment; final exam |

| CO No. | CO Statement<br>*At the end of the course, and having completed the essential readings and activities, students would be able to:* | Correspo nding PO(s)* | Domains and Taxonomy level(s) | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | and factors in ensuring good governance | | | | |
| CO3 | **critically analyze** the issues and challenges of Bangladesh government and politics in the light of glorious history | PO(6), PO(9) | C4, C5, C6<br>A3<br>P1, P6, | Lectures; power point presentations; Group Discussion; Home work | Class test; extempore test; assignment; final exam |
| CO4 | **develop** understanding of the key actors, institutions and processes of administrative systems, public policy process, constitutional bodies, NGOs, local government and project management | PO(6), PO(7) | C2, C5, C6<br>A3<br>P6 | Lectures; power point presentations; Group discussion; Home work | Class test; extempore test; assignment; final exam |
| CO5 | **know** the origins and functions of international organizations to perform as responsible global citizen | PO(6), PO(7), PO(9) | C1, C2, C3<br>A3<br>P6 | Lectures; power point presentations; Home work | Class test; assignment; final exam |

*PO (1): Engineering knowledge; PO(2): Problem analysis; PO (3): Design/development of solutions; PO(4): Investigation; PO(5) Modern tool use; PO(6): The engineer and society; PO(7): Environment and sustainability; PO(8): Ethics; PO(9): Individual work and teamwork; PO(10): Communication; PO(11): Project management and finance; PO(12): life-long learning
**C -Cognitive: **C1** – Knowledge, **C2** – Comprehension, **C3** – Application, **C4** – Analysis, **C5** – Synthesis, **C6** – Evaluation
A-Affective: **A1**: Receiving; **A2**: Responding; **A3**:Valuing; **A4**: Organizing; **A5**: Characterizing
P- Psychomotor: **P1**: Perception; **P2**: Set; **P3**:Guided Response; **P4**: Mechanism; **P5**: Complex Overt Response; **P6**: Adaptation; **P7**: Organization

## 9. Mapping of **Knowledge** Profile, Complex Engineering **Problem** Solving and Complex Engineering **Activities**

| COs | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO-1 | | | | | | | | | | | | | | | | | | | | |
| CO-2 | | | | | | | | | | | | | | | | | | | | |
| CO-3 | | | | | | | ✓ | | | | | | | | | | | | | |
| CO-5 | | | | | | | ✓ | | | | | | | | | | | | | |

## 10. Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1-5 | Introduction to government and politics, Concept of society and state, Sovereignty, Constitution, Citizenship: Rights and Duties | Rodee and others (1957), Dyck (2006), Rhodes and others (2008), Shively (2011) | CO1 |
| 6-8 | Forms of Government: Democracy, Dictatorship, Parliamentary, Presidential, Socialism, Marxism | Dyck (2006), Rhodes and others (2008), Hasanuzzaman (1998), | CO1 |

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| | | Shively (2011), Harold (1967) | |
| 9-10 | Organs of Government Legislature, Executive Judiciary | Dyck (2006), Shively (2011), | CO1 |
| 11 | Bureaucracy: Definition and Function | Panandiker (2000) | CO2 |
| 12-13 | Good Governance: Government, Private Sector, Civil Society | Levi-Faur (2012), Sobhan (2000),<br>Aminuzzamaz (2006),<br>Panandiker (2000),<br>Hye (2000), | CO2 |
| 14-19 | Historical and political background of Bangladesh: Language Movement, Six Point Movement, Mass Upsurge of 1969, Impact of 1970s Election and Emergence of Bangladesh | GoB (2020), Choudhury (1994),<br>Jahan (1977),<br>Rahman (2020) | CO3 |
| 20-21 | Constitution of Bangladesh, Major amendments | GoB (2020) | |
| 22 | Local Government | Siddiqui (2008), Ali (1979), GoB (2014), Ali, Maqsood (1981) | CO4 |
| 23-24 | Public policy making, Non-government Organizations | Birkland. T. A. (2014) | CO4 |
| 25 | Development project management | Larson. E. W., & Gray. C. F. (2011) | CO4 |
| 26 | Constitutional Bodies | GoB (2020), Choudhury, D. (1994) | CO4 |
| 27 | Foreign Policy of Bangladesh | GoB (2020) | CO4, CO5 |
| 28 | United Nations Organizations | Annan (2002) | CO5 |

## 11. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

## 12. Distribution of Marks

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**13.** Textbooks/References

Textbook:


- Dyck, R. (2006). Studying Politics: An Introduction to Political Science,  Nashville: Nelson Thomson.
- Rhodes, R. A., Binder, S. A., & Rockman, B. A. (2008). The Oxford Handbook of Political Institutions, Oxford: Oxford University Press
- Shively, W. P. (2011). Power & Choice: An Introduction to Political Science, New York: McGraw-Hill
- Larson, E. W., & Gray, C. F. (2011). Project management: The managerial process (5Th edition)., New York: McGraw-Hill Irwin Publishers
- Birkland, T. A. (2014). An introduction to the policy process: Theories, concepts and models of public policy making, London: Routledge.


References


- Carlton Clymer Rodee, Totton James Anderson and Carl Quimby Christol (1957), Introduction to Political Science, New York: McGraw-Hill Book Company.
- Harold, J. L. (1967), A Grammar of Politics, London: George Allen and Urwin Ltd
- Islam, Sirajul (2018), History of Bangladesh, Dhaka: Asiatic Society of Bangladesh
- Jahan Rounaq (1977), Pakistan: Failure in National Integration, Dhaka: UPL
- Choudhury, D. (1994), Constitutional Development in Bangladesh, Oxford University Press
- Hasanuzzaman, A. M. (1998), Role of Opposition in Bangladesh Politics, Dhaka: UPL
- Panandiker, P.V. (ed.) (2000), Problems of Governance in South Asia, Dhaka: UPL.
- Sobhan, R. (2000), Towards a Theory of Governance, Dhaka: UPL.
- Levi-Faur, D. (2012), The Oxford Handbook of Governance, Oxford: Oxford University Press.
- Kamal Siddiqui (2008), Local Government of Bangladesh, Dhaka: UPL
- Aminuzzamaz. S. A (2006), Governance and Development: Bangladesh nand Regional Experiences, Dhaka: Shrabon Prokashani
- Hye. H. A  (2000), Governance: South Asian Perspective, Dhaka: UPL
- GOB. (2014) The Constitution of the Peoples Republic of Bangladesh. Dhaka: Legislative and Parliamentary Affairs Division
- Annan, K (2002), Strengthening of the United Nations: An Agenda for further Change, New York: United Nations General Assembly.
- Muldoon, J and Muldoon, J. P. (eds) (1999), Multilateral Diplomacy and the United Nations Today, New York: Westview Press, Boulder Colo.


## 20.64 Description of Course MATH 137

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | **Course Number** | MATH 137 |
| | **Course Title** | Differential and Integral Calculus, Matrices |
| | **Credit (Contact) Hours** | 3.0 (3.0) |
| **2.** | **Level and Term (Section)** | Level-1, Term-1 |
| | **Academic Session** | July 2021 |
| **3.** | **Type of Course** | Core Course |
| | **Offered to** | Department of CE |
| **4.** | **Pre-requisite Course(s)** | None |
| **5.** | **Course Website** | https://---.math.buet.ac.bd |
| **6.** | **Lecture Schedule** | Xday (00:00-00:00 am)<br>Yday (00:00-00:00 am)<br>Zday (00:00-00:00 am) |
| **7.** | **Important Dates** | For important dates and examination schedules and latest updates, please follow the course website |

**8. Course Teacher(s)**

| Name (Initials): | Office: | Email: | Consultation Hour(s) |
|---|---|---|---|
| **Teacher 1** | X | x@math.buet.ac.bd | Xday (00:00-00:00 am) |
| **Teacher 2** | Y | y@math.buet.ac.bd | Yday (00:00-00:00 am) |

## SECTION B: Course Details

**9.** Course Content (As approved by the Academic Council)

- Differential Calculus: Limits, continuity and differentiability, Successive differentiation and Leibnitz's theorem, Expansion of functions, indeterminate forms, Partial differentiation, Euler's theorem, Tangent and Normal, maximum and minimum values of functions of single variable.
- Integral Calculus: Integration by parts, standard integrals, Successive reduction, Definite integrals, Beta function and Gamma function. multiple integrals.
- Matrices: Definition of matrices, Algebra of matrices, inverse of matrix, Elementary transformations of matrices and rank. Solution of linear equations, Eigenvalues and eigenvectors, Cayley-Hamilton theorem.

**10. Course Objectives**

- To provide the appropriate tools of calculus to solve applied problems.
- To provide the standard methods of indefinite and definite integrals with applications.
- To understand the fundamental properties of matrices including determinants, inverse matrices, matrix factorizations, eigenvalues, eigenvectors along with their applications; understanding the basic concepts of the system of linear equations, apply the matrix calculus to solve linear systems of equations.

**11. Knowledge required**

Familiarity with basic properties of set theory and function; fundamental concepts of pre-calculus and preliminary knowledge to solve algebraic and transcendental equations.

**12. Course Outcomes**

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s) | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| **1** | **Explain** the fundamental concepts of limits, derivatives, and expansion of functions. | PO(a) | **C3** | Lectures, Homework | Written exams, Assignment |
| **2** | **Apply** the appropriate tools of calculus to solve applied problems. | PO(a) | **C3** | Lectures, Homework | Written exams, Assignment |
| **3** | **Develop** rigorous knowledge to solve indefinite and definite integrals and multiple integrals | PO(b) | C3 | Lectures, Homework | Written exams, Assignment |
| **4** | **Demonstrate** the idea of rank, eigen values and eigen vector space | PO(b) | C3 | Lectures, Homework | Written exams, Assignment |

*__PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning.__

**The cognitive domain (C) and its Taxonomy Levels (1 to 6) aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:

C1- knowledge/remember; C2-understand/explain/estimate; C3-apply; C4-analysis; C5- evaluate/judge/verify; C6-synthesis/design/create/construct.

**13. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment in any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**14. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**15. Textbooks**

- Calculus (10th edition) by Howard Anton, Irl Bivens and Stephen Davis.
- Integral Calculus by A.K. Hazra.
- Advanced Engineering Mathematics by Erwin Kreyszig (Wiley).
- Elementary Linear Algebra by Howard Anton and Chris Rorres

**16. Reference Books**

- Differential and Integral Calculus by P.N. Chatterjy.
- Calculus (10th edition) by Howard Anton, Irl Bivens and Stephen Davis.
- Differential and integral Calculus by B C Das & B N Mukherjee
- Theory and Problems of Linear Algebra (Schaum's Outline Series) by Seymour Lipschutz

**N.B.** Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**17. Lecture Plan**

**Weekly schedule: Differential Calculus**

| **Week** | **Topics** | **Teacher's Initial/Remarks** |
|---|---|---|
| Week-1 | Limits | |
| Week-2 | continuity and differentiability | |
| Week-3 | continuity and differentiability | |
| Week-4 | Successive differentiation and Leibnitz's theorem | |
| Week-5 | **Class Test**<br>Expansion of functions | |
| Week-6 | Expansion of functions | |
| Week-7 | indeterminate forms | |
| Week-8 | Partial differentiation, Euler's theorem, | |
| Week-9 | Tangent and Normal | |
| Week-10 | Tangent and Normal | |
| Week-11 | Tangent and Normal | |
| Week-12 | maximum and minimum values of functions of single variable. | |
| Week-13 | maximum and minimum values of functions of single variable. | |
| Week-14 | **class test**<br>Review class | |

**Weekly schedule: For Integral Calculus**

| Week | Topics | Teacher's Initial/Remarks |
|---|---|---|
| Week-1 | Integration by parts | |
| Week-2 | Integration by parts | |
| Week-3 | standard integrals | |
| Week-4 | standard integrals | |
| Week-5 | Successive reduction | |
| Week-6 | Successive reduction | |
| Week-7 | Definite integrals | |
| Week-8 | Definite integrals | |
| Week-9 | **Class Test**<br>Beta function and Gamma function | |
| Week-10 | Beta function and Gamma function | |
| Week-11 | multiple integrals. | |
| Week-12 | multiple integrals. | |
| Week-13 | multiple integrals. | |
| Week-14 | Review class | |

**Weekly schedule: For Matrices**

| Week | Topics | Teacher's Initial/Remarks |
|---|---|---|
| Week-1 | Definition of matrices | |
| Week-2 | Definition of matrices | |
| Week-3 | Algebra of matrices | |
| Week-4 | inverse of matrix | |
| Week-5 | inverse of matrix | |
| Week-6 | Elementary transformations of matrices and rank | |
| Week-7 | Elementary transformations of matrices and rank | |
| Week-8 | Solution of linear equations | |
| Week-9 | Solution of linear equations | |
| Week-10 | **Class Test**<br>Eigenvalues and eigenvectors | |
| Week-11 | Eigenvalues and eigenvectors | |
| Week-12 | Eigenvalues and eigenvectors | |
| Week-13 | Cayley-Hamilton theorem. | |
| Week-14 | Review class | |

**18. Important University Policies:**

- Rules and regulations for the undergraduate programmes: https://www.buet.ac.bd/info/Academicinformation/RulesUndergradprogram

## 20.65 Description of Course MATH 139

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | **Course Number** | MATH 139 |
| | **Course Title** | Differential Equations and Statistics |
| | **Credit (Contact) Hours** | 3.0 (3.0) |
| **2.** | **Level and Term (Section)** | Level-1, Term-2 |
| | **Academic Session** | July 2022 |
| **3.** | **Type of Course** | Core Course |
| | **Offered to** | Department of CE |

4. **Pre-requisite Course(s)** None
5. **Course Website** https://---.math.buet.ac.bd
6. **Lecture Schedule** Xday (00:00-00:00 am)
   Yday (00:00-00:00 am)
   Zday (00:00-00:00 am)
7. **Important Dates** For important dates and examination schedules and latest updates, please follow the course website
8. **Course Teacher(s)**

| Name (Initials): | Office: | Email: | Consultation Hour(s) |
|---|---|---|---|
| **Teacher 1** | X | x@math.buet.ac.bd | Xday (00:00-00:00 am) |
| **Teacher 2** | Y | y@math.buet.ac.bd | Yday (00:00-00:00 am) |

## SECTION B: Course Details

9. Course Content (As approved by the Academic Council)

   **Ordinary Differential Equations:** Formation of differential equations. Solution of first order differential equations by various methods. Solution of differential equations of first order but higher degree. Solution of general linear differential equations of second and higher order with constant coefficients. Solution of Euler's homogeneous linear differential equations.

   **Partial Differential Equations:** Introduction. Linear and nonlinear first order differential equations. Standard forms. Linear equations of higher order. Equations of the second order with variable coefficients.

   **Statistics:** Measures of central tendency and standard deviation. Moments, skewness and kurtosis. Elementary probability theory and discontinuous probability distribution. Continuous probability distributions, e.g. normal and exponential.

10. **Course Objectives**

- To provide the basic concept of differential equations, their solution tecniques along with their physical significance.
- To understand fundamental concepts in probability and statistics. To enable students to apply rules and algorithm of probability and statistics in various logical problems. To enable students maneuver mathematical probabilistic models for different problems, to analyze them and to interpret the results.

11. **Knowledge required**

Familiarity with basic properties of set theory and function; fundamental concepts of pre-calculus, differential and integral calculus; and preliminary knowledge to solve algebraic and transcendental equations.

12. **Course Outcomes**

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s) | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | **Formulate** differential equations to solve 1$^{st}$ and higher order linear differential equations. | PO(b) | C5 | Lectures, Homework | Written exams; assignment |
| 2 | **Apply** the appropriate methods to solve the linear and non-linear differential equations. | PO(a) | C3 | Lectures, Homework | Written exams; assignment |
| 3 | **Develop** rigorous knowledge to solve linear and non-linear partial | PO(c) | C6 | Lectures, Homework | Written exams; assignment |

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s) | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| | differential equations of Physical Models | | | | |
| **4** | **Interpret** the basic idea of statistics, probability theory, hypothesis testing and regression analysis. | PO(c) | C3 | Lectures, Homework | Written exams; assignment |

*PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning.

**The cognitive domain (C) and its Taxonomy Levels (1 to 6) aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:

**C1- knowledge/remember; C2-understand/explain/estimate; C3-apply; C4-analysis; C5-evaluate/judge/verify; C6- synthesis/design/create/construct.**

### 13. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment in any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

### 14. Distribution of Marks

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

### 15. Textbooks

- Elementary Differential Equations by Earl D. Rainville and Phillip E. Bedient.
- A First Course in Differential Equations with Modeling Applications by Dennis G. Zill.
- Ordinary and Partial Differential Equations by M.D. Raisinghania
- Elements of Partial Differential Equations by Ian Naismith Sneddon.
- Probability and Statistics for Engineers and Scientists – Walpole, Myers, Myers, and Ye, Pearson Education, Inc., Ninth Edition, 2012.

**N.B.** Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

### 16. Reference Books

- Differential Equations with Applications by M. M. K. Chowdhury.
- Advanced Engineering Mathematics by Erwin Kreyszig (Wiley)\

- Introduction to Partial Differential Equations and Boundary Value Problems by Rene Dennemeyer.
- Element of Probability and Statistics, By Frank L. Wolf
- Probability and Statistics with Applications, By Y. Leon Maksoudian
- Probability and Statistics for Engineers, By Erwin Miller & John E. Freund.


**17. Lecture Plan**

**For Differential Equations**

| **Weekly plan for course content and mapping with COs** | |
|---|---|
| **Week** | **Topics** |
| Week-1 | Introduction to differential equations. |
| Week-2 | Degree and order of ordinary differential equations, Formation of differential equations. |
| Week-3 | Solution of first order differential equations by various methods (separable form and reducible to separable form). |
| Week-4 | Solution of first order differential equations by various methods (homogeneous form and reducible to homogeneous form). |
| Week-5 | Solution of first order differential equations by various methods (linear differential equation and Bernoulli's differential equation). |
| Week-6 | Solution of first order differential equations by various methods (exact differential equation, non-exact differential equation and integrating factor by inspection). |
| Week-7 | Solution of first order differential equations by various methods (exact differential equation, non-exact differential equation and integrating factor by inspection). |
| Week-8 | Application of first order differential equations, Solution of differential equations of first order but higher degree. |
| Week-9 | Solution of general linear equations of second and higher order with constant coefficients (homogeneous and non-homogeneous). |
| Week-10 | Solution of general linear equations of second and higher order with constant coefficients (homogeneous and non-homogeneous). |
| Week-11 | Solution of general linear equations of second and higher order with constant coefficients (homogeneous and non-homogeneous). |
| Week-12 | Solution of homogeneous linear equations (Cauchy-Euler equations). |
| Week-13 | Solution of homogeneous linear equations (Cauchy-Euler equations). |
| Week-14 | Review class |

**For Partial Differential Equations**

| Weekly plan for course content and mapping with Cos | |
|---|---|
| **Week** | **Topics** |
| Week-1 | Introduction to partial differential equations. |
| Week-2 | Introduction to partial differential equations. |
| Week-3 | Linear partial differential equations of first order. |
| Week-4 | Linear partial differential equations of first order. |
| Week-5 | Non-linear partial differential equations of first order. |
| Week-6 | Non-linear partial differential equations of first order. |
| Week-7 | Standard forms. |
| Week-8 | Linear equations of higher order. |
| Week-9 | Linear equations of higher order. |
| Week-10 | Linear equations of higher order. |
| Week-11 | Linear equations of higher order. |
| Week-12 | Linear equations of higher order. |
| Week-13 | Equations of the second order with variable coefficients. |
| Week-14 | Review class |

**For Statistics**

| **Week** | **Topics** |
|---|---|
| Week-1 | Measures of central tendency. |
| Week-2 | Measures of central tendency, Standard deviation. |
| Week-3 | Moments, skewness and kurtosis. |
| Week-4 | Moments, skewness and kurtosis. |
| Week-5 | Elementary probability theory, definitions, Conditional probability, partitions, total probability, Bayes' theorem. |
| Week-6 | Discontinuous probability distributions. |
| Week-7 | Continuous probability distributions. |
| Week-8 | Continuous probability distributions. |
| Week-9 | Characteristics of distributions. Elementary sampling theory. Estimation. |

| Week | Topics |
|---|---|
| Week-10 | Hypothesis testing. |
| Week-11 | Hypothesis testing. |
| Week-12 | Regression analysis. |
| Week-13 | Regression analysis. |
| Week-14 | Review class |

## 20.66 Description of Course MATH 237

**SECTION A: General Information**

| | | |
|---|---|---|
| **1.** | **Course Number** | MATH 237 |
| | **Course Title** | Laplace Transform and Vector Analysis |
| | **Credit (Contact) Hours** | 3.0 (3.0) |
| **2.** | **Level and Term (Section)** | Level-2, Term-1 |
| | **Academic Session** | July 2021 |
| **3.** | **Type of Course** | Core Course |
| | **Offered to** | Department of Civil Engineering |
| **4.** | **Pre-requisite Course(s)** | None |
| 5. | **Course Website** | https://---.math.buet.ac.bd |
| **6.** | **Lecture Schedule** | Xday (00:00-00:00 am)<br>Yday (00:00-00:00 am)<br>Zday (00:00-00:00 am) |
| **7.** | **Important Dates** | For important dates and examination schedules and latest updates, please follow the course website |

**8. Course Teacher(s)**

| Name (Initials): | Office: | Email: | Consultation Hour(s) |
|---|---|---|---|
| **Teacher 1** | X | x@math.buet.ac.bd | Xday (00:00-00:00 am) |
| **Teacher 2** | Y | y@math.buet.ac.bd | Yday (00:00-00:00 am) |

**SECTION B: Course Details**

**9.** Course Content (As approved by the Academic Council)

**Laplace Transforms:** Definition of Laplace transforms. Sufficient conditions for existence of Laplace transforms. Inverse Laplace transforms. Laplace transforms of derivatives. The unit step function. Periodic function. Some special theorems on Laplace transforms. Partial fraction. Solution of differential equations by Laplace transforms.

**Vector Analysis:** Scalars and vectors, equality of vectors. Addition and subtraction of vectors. Multiplication of vectors by scalars. Position vector of a point. Scalar and vector product of two vectors and their geometrical interpretation. Triple and multiple product of vectors. Linear dependence and independence of vectors. Definition of line, surface and volume integrals. Gradient, divergence and curl of point functions. Gauss's theorem, Stokes' theorem, Green's theorem and their applications.

**10. Course Objectives**

- To understand the properties of Laplace transform, perform operations on Laplace transform and inverse Laplace transform, solve linear differential equations with constant and variable coefficients as well as discontinuous input functions using the Laplace transform.
- To develop better understanding of key concepts concerning scalar and vector fields. Gain deeper knowledge of multivariate differentiation operations such as Gradient, Divergent and Curl. Master the

Integral Theorems at the core of Vector Analysis. Learn the utility of Vector Analysis by learning its relevance to equations describing the dynamics of electric and magnetic fields.

**11. Knowledge required**

Familiarity with basic properties of vectors, set, real number system and function; fundamental concepts of pre-calculus, differential and integral calculus; and preliminary knowledge to solve algebraic equation, ordinary and partial differential equations.

**12. Course Outcomes**

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s) | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | **Understand** the concepts Laplace and inverse Laplace transform to solve differential equations | PO(a) | C2 | Lectures, Homework | Written exams; assignment |
| 2 | **Demonstrate** the concepts of vector algebra, calculus, Gradient, Divergent and Curl. | PO(b) | C3 | Lectures, Homework | Written exams; assignment |
| 3 | **Apply** the concepts of multiple integrals and various vector integral theorems for solving different types of problems | PO(a) | C3 | Lectures, Homework | Written exams; assignment |

*__PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): The engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning.__

**The cognitive domain (C) and its Taxonomy Levels (1 to 6) aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:
C1- knowledge/remember; C2-understand/explain/estimate; C3-apply; C4-analysis; C5- evaluate/judge/verify; C6-synthesis/design/create/construct.

**13. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment in any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**14. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**15. Textbooks**

- Theory and Problems of Laplace Transforms, Schaum's outline Series, Murray R. Spiegel.
- Advanced Engineering Mathematics by Peter V. O’Neil.
- Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
- Vector Analysis with Applications by Md. Ali Ashraf and Md. Abdul KhaleqHazra.

**16. Reference books**

- Schaum’s Outline of Theory and Problems of Vector Analysis by Murray R. Spiegel.

- Vector Analysis by M. D. Raisinghania.
- Advanced Engineering Mathematics, S. Chand Publishing, H. K. Dass.

**N.B.** Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**17. Lecture Plan**

**Laplace Transform**

| **Week** | **Topics** |
|---|---|
| **Week-1** | Introduction to Laplace transform |
| **Week-2 to 3** | Elementary transformation and properties |
| **Week- 4 to 6** | Laplace transform of derivatives, unit step and periodic functions |
| **Week-7 to 8** | Special theorems of Laplace transform, Inverse Laplace transform, Convolution |
| **Week- 9 to 11** | Solution of differential equation by Laplace transforms |
| **Week-12 to 13** | Evaluation of integrals by Laplace's transforms. |
| **Week-14** | Review **Class** |

**Vector Analysis**

| **Week** | **Topics** |
|---|---|
| **Week-1** | Multiple product of vectors. |
| **Week-2** | Linear dependence and Independence of vectors. |
| **Week-3** | Differentiation and integration of vectors. |
| **Week-4** | Solving problems related to differentiation and integration of vector functions. |
| **Week-5** | Gradient of scalar functions, divergence and curl of vector functions. |
| **Week-6** | Integral forms of gradient, divergence and curl. |
| **Week-7** | **Class Test** |
| **Week-8** | Line integrals. |
| **Week-9** | Green's theorem and solving problems related to this theorem. |
| **Week-10** | Surface and volume integrals. |
| **Week-11** | Gauss's theorem and solving problems related to this theorem. |
| **Week-12** | Stokes theorem and solving problems related to this theorem |
| **Week-13** | **Class Test** |
| **Week-14** | Review Class |

## 20.67 Description of Course PHY 101

### SECTION A: General Information

| | | |
|---|---|---|
| 1 | **Course Title** | : Physical Optics, Waves & Oscillations and Heat & Thermodynamics |
| 2 | **Type of Course** | : Non-departmental course |
| 3 | **Offered to** | : Department of Civil Engineering |
| 4 | **Pre-requisite Course(s)** | : N/A |

### SECTION B: Course Details

**1.** Course Content (As approved by the Academic Council)

**Physical Optics:** Theories of light; Interference of light, Young's double slit experiment, Displacement of fringes and its uses, Fresnel Bi-prism, Interference at wedge shaped films, Newton's rings, Interferometers; Diffraction of light; Fresnel and Fraunhoffer diffraction, Diffraction by single slit, Diffraction from a circular aperture, Resolving power of optical instruments, Diffraction at double slit and N-slits-diffraction grating; Polarization; Production and analysis of polarized light, Brewster's Law, Malus Law, Polarization by double refraction, Retardation plates, Nicol prism, Optical activity , Polarimeters, Polaroid.

**Waves & Oscillations:** Differential equation of a Simple Harmonic Oscillator, total energy and average energy, Combination of simple harmonic oscillations, Lissajous figures, spring- mass system, Calculation of time period of torsional pendulum, Damped oscillation, Determination of damping co-efficient. Forced oscillation, Resonance, Two-body oscillations, Reduced mass, Differential equation of a progressive wave, Power and intensity of wave motion, Stationary wave, Group velocity and phase velocity, Architectural acoustics, Reverberation and Sabine's formula.

**Heat & Thermodynamics**: Principle of temperature measurements: Platinum resistance thermometer, Thermo-electric thermometer, Pyrometer; Kinetic theory of gases: Maxwell's distribution of molecular speeds, Mean free path, Equipartition of energy, Brownian motion, Van der Waal's equation of state, Review of the First Law of Thermodynamics and its application, Reversible and irreversible processes, Second Law of thermodynamics, Carnot cycle; Efficiency of heat engines, Carnots theorem, Entropy and disorder, Thermodynamic functions, Maxwell relations, Clausius-Clapeyron equation, Gibbs phase rule, Third Law of Thermodynamics.

**2. Course Objectives**

Objective 1: To develop logical and critical thinking with scientific knowledge of physical optics, waves & oscillation, and heat & thermodynamics required for the students of civil engineering.

Objective 2: To understand the different laws of Physics associated with physical optics, waves & oscillation, and heat & thermodynamics, and apply them to solve the real life problems.

**3.** Knowledge required

Insert previous knowledge requirements: N/A

**4. Course Outcomes**

| CO No. | CO Statement<br>At the end of the course, a student should be able to | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| CO1 | Describe the basic laws of Physics related to physical optics, waves & oscillation, and heat & thermodynamics to express different phenomena in the physical world. | PO(a) | C1 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |
| CO2 | Explain the fundamental concepts and theories of physical optics, waves & oscillation, and heat & thermodynamics applicable for different physical conditions. | PO(a) | C2 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |
| CO3 | Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences. | PO(a) | C3, C4 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |

*POs
PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): Engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
**Domains
**C-Cognitive** : C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
**A-Affective** : A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
**P-Psychomotor**: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

## 5. Lecture Plan

| wk | Lecture Topics | Corresponding CO(s) |
|---|---|---|
| 1 | • Theories of light, Interference of light, Young's double slit experiment<br>• Introductory discussion of this course; Definition of wave motion and Simple harmonic motion (SHM), differential equation of SHM.<br>• Thermometry, different types of thermometers, platinum resistance thermometer, thermo-electric thermometer | CO1, CO2, CO3 |
| 2 | • Displacements of fringes and its uses, Fresnel bi-prism<br>• Solution of differential equation of SHM, velocity and acceleration of SHM, Significance of angular frequency, and solving mathematical problems.<br>• Kinetic theory of gases: Maxwell distribution of velocities, mean velocity | CO1, CO2, CO3 |
| 3 | • Interference at parallel and wedge-shaped films<br>• Total energy and average energy of SHM, and solving mathematical problems related to energy of SHM<br>• Most probable velocity, root mean square velocity, most probable energy, and average energy | CO1, CO2, CO3 |
| 4 | • Newton's rings, interferometers<br>• Examples of SHM: spring-mass system, effect of spring mass in the oscillation (effective mass), torsional pendulum, and solving mathematical problems<br>• Degrees of freedom, equipartition of energy, ratio of specific heats of monoatomic, diatomic, and triatomic molecules | CO1, CO2, CO3 |
| 5 | • Solving mathematical problems related to interference of light<br>• Combination of simple harmonic motions (in a same line and right angles), Lissajous figures<br>• Class Test (Heat & Thermodynamics) | CO1, CO2, CO3 |
| 6 | • Class Test ( Physical Optics)<br>• Damped harmonic oscillation (over-, under- and critical-damping conditions), quality factor, and logarithmic decrement<br>• Brownian motion, mean free path, solving mathematical problems of previous lectures | CO1, CO2, CO3 |
| 7 | • Diffraction of light, Fresnel and Fraunhofer diffraction, diffraction due to single slit<br>• Forced oscillation, resonance, two-body oscillations and reduced mass<br>• Van der Waals’ equation of state, finding critical constants, and Van der Waals’ constants | CO1, CO2, CO3 |
| 8 | • Diffraction from a circular aperture, diffraction at double slits<br>• Solving mathematical problems related to damped, forced and two-body oscillations<br>• First law of thermodynamics, applications of first law | CO1, CO2, CO3 |
| 9 | • N-slits-diffraction grating<br>• Class Test ( Waves & Oscillations)<br>• Reversible and irreversible processes, Carnot’s cycle, second law of thermodynamics | CO1, CO2, CO3 |
| 10 | • Resolving power of optical instruments<br>• Various types of waves, progressive wave equation and differential equation of a progressive wave, and solving mathematical problems.<br>• Carnot’s theorem, entropy, entropy in reversible and irreversible processes | CO1, CO2, CO3 |
| 11 | • Solving mathematical problems related to diffraction of light<br>• Energy, power and intensity of wave motion, stationary wave, analytical treatment of stationary wave, and solving mathematical problems. | CO1, CO2, CO3 |

| wk | Lecture Topics | Corresponding CO(s) |
|---|---|---|
| | • Thermodynamic functions and potentials, mathematical problems | |
| 12 | • Polarization of light, production and analysis of polarized light, Brewster's Law, Malus law<br>• Energy of stationary wave, group velocity, phase velocity and relation between group velocity and phase velocity.<br>• Maxwell's thermodynamic relations | CO1, CO2, CO3 |
| 13 | • Polarization by double refraction, retardation plates, Nicol prism, optical activity<br>• Architectural acoustics, reverberation and Sabine's reverberation formula for growth of intensities<br>• Clausius-Clapeyron equation, specific heat for perfect gas and Van der Waals' gas | CO1, CO2, CO3 |
| 14 | • Polarimeters, polaroid, solving mathematical problems related to polarization of light<br>• Sabine's reverberation formula for decay of intensities, equation for reverberation time and solving mathematical problems related to reverberation.<br>• Gibbs phase rule, third law of thermodynamics, and its applications for perfect gas | CO1, CO2, CO3 |

**6. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**7. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**8. Textbook/ Reference**

3. Fundamentals of Physics; D. Halliday, R. Resnick, and J. Walker
4. Fundamentals of Optics; F. A. Jenkins, and H. E. White
5. Vibrations & Waves; A. P. French
6. Waves & Oscillations; N. Subrahmanyum and Brij Lal
7. Heat and Thermodynamics; N. Subrahmanyum and Brij Lal
8. Physics for Engineers - Part-1; Giasuddin Ahmad

## 20.68 Description of Course PHY 102

### SECTION A: General Information

| | | |
|---|---|---|
| 1 | **Course Title** | : Physics Sessional |
| 2 | **Type of Course** | : Non-departmental course |
| 3 | **Offered to** | : Department of Civil Engineering |
| 4 | **Pre-requisite Course(s)** | : N/A |

## SECTION B: Course Details

**1.** Course Content (As approved by the Academic Council)

Experiments based on waves & oscillations, heat & thermodynamics, electricity & magnetism, optics, and modern physics.

**2. Course Objectives**

Objective 1: To gain practical knowledge about theories of Physics by performing different experiments.
Objective 2: To develop analytical and scientific report writing skills.

**3.** Knowledge required

Insert previous knowledge requirements: N/A

**4. Course Outcomes**

| CO No. | CO Statement<br>At the end of the course, a student should be able to - | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| CO1 | Describe various experimental techniques, and use different instruments to collect, tabulate the data. | PO(a) | C1, C3 | Classwork, Q & A Forums | Classwork |
| CO2 | Analyse data, plot graphs, and connect the results for qualitative understanding. | PO(a) | C3, C4 | Classwork, Q & A Forums | Classwork |
| CO3 | Interpret the result, draw conclusions and prepare laboratory report. | PO(a) | C3 | Classwork, Q & A Forums | Classwork |

***POs**
PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): Engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning
****Domains**
**C-Cognitive** : C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation
**A-Affective** : A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing
**P-Psychomotor**: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

**5. Lecture Plan**

| wk | Lecture Topics | Corresponding CO(s) |
|---|---|---|
| 1 | Introductory class | |
| 2 | W2: Determination of the frequency of a tuning fork by Melde's apparatus | CO1, CO2, CO3 |
| 3 | W3: Determination of the spring constant and the effective mass of a loaded spring | |
| 4 | H2: Determination of the pressure-coefficient of air by a constant volume air thermometer | |
| 5 | H4: Determination of the thermal conductivity of a bad conductor by Lee's method | |
| 6 | O4: Determination of the radius of curvature of a Plano-convex lens by the Newton's ring method | |
| 7 | O5: Determination of the specific rotation of sugar solution by a polarimeter | |
| 8 | M1: Determination of the threshold frequency for the material of a photo-cathode and hence find the value of the Planck's constant | |
| 9 | M2: Determination of the linear absorption coefficient and mass absorption coefficient of Aluminum using a $^{137}Cs$ radioactive source and verification of the inverse square law of gamma radiation | |
| | E3: Verification of Biot-Savart law and Tangent law | |

| wk | Lecture Topics | Corresponding CO(s) |
|---|---|---|
| 10 | E5: Determination of the temperature coefficient of the resistance of the material of a wire | |
| 11 | H5: Calibration of a given thermocouple | |
| 12 | H6: Determination of the melting point of a solid using the calibration curve obtained in experiment H5 | |
| 13 | VL-M3: Determination of lattice constant of NaCl crystal using an X-ray diffraction simulator<br>E6: Determination of dielectric constant of materials using a parallel plate capacitor<br>H7: Determination of the mechanical equivalent of heat by the electrical method<br><br>One experiment will be performed by each student per week. | |
| 14 | Sessional Quiz | |

**6. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment will be evaluated based on viva and laboratory report, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Quiz: A comprehensive quiz will be held at the end of the term following the guideline of the Department.

**7. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 70% |
| Quiz | 20% |
| Total | 100% |

**8. Textbook/ Reference**

1. Practical Physics for Degree Students; Giasuddin Ahmad and Md. Sahabuddin.
2. Advanced Practical Physics for students; B. L. Worsnop and H. T. Flint

## 20.69 Description of Course PHY 151

### SECTION A: General Information

| | | |
|---|---|---|
| 1 | **Course Title** | : Structure of Matter, Electricity & Magnetism and Modern Physics |
| 2 | **Type of Course** | : Non-departmental course |
| 3 | **Offered to** | : Department of Civil Engineering |
| 4 | **Pre-requisite Course(s)** | : N/A |

### SECTION B: Course Details

**1.** Course Content (As approved by the Academic Council)

**Structure of Matter:** crystalline and non-crystalline solids, single crystal and polycrystal solids, unit cell, crystal systems, co-ordinations number, crystal planes and directions, NaCl and CsCl structure, packing factor, miller indices, relation between interplanar spacing and Miller indices, Bragg's law, methods of determination of interplanar spacing from diffraction patterns; defects in solids: point defects, line defects, bonds in solids, interatomic distances, calculation of cohesive and bonding energy; introduction to band theory: distinction between metal, semiconductor and insulator.

**Electricity and Magnetism:** crystalline and non-crystalline solids, single crystal and polycrystal solids, unit cell, crystal systems, co-ordinations number, crystal planes and directions, NaCl and CsCl structure, packing factor, miller indices, relation between interplanar spacing and Miller indices, Bragg's law, methods of determination of interplanar spacing from diffraction patterns; defects in solids: point defects, line defects, bonds in solids, interatomic distances, calculation of cohesive and bonding energy; introduction to band theory: distinction between metal, semiconductor and insulator.

**Modern Physics:** Michelson-Morley's experiment, Galilean transformation, special theory of relativity and its consequences; quantum theory of radiation; photo-electric effect, Compton effect, wave particle duality, interpretation of Bohr's postulates, radioactive disintegration, properties of nucleus, nuclear reactions, fission, fusion, chain reaction, nuclear reactor.

## 2. Course Objectives

Objective 1: To develop logical and critical thinking with scientific knowledge of structure of matter, electricity & magnetism, and modern physics required for the students of civil engineering.

Objective 2: To understand the different laws of physics associated with structure of matter, electricity & magnetism and modern physics, and apply them to solve the real life problems.

## 3. Knowledge required

Insert previous knowledge requirements: N/A

## 4. Course Outcomes

| CO No. | CO Statement<br>At the end of the course, a student should be able to | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| CO1 | Describe the basic laws of physics related to structure of matter, electricity & magnetism, and modern physics to express different phenomena in the physical world. | PO(a) | C1 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |
| CO2 | Explain the fundamental concepts and theories of structure of matter, electricity & magnetism, and modern physics applicable for different physical conditions. | PO(a) | C2 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |
| CO3 | Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences. | PO(a) | C3, C4 | e.g., Lectures, Homework | e.g., Written exams; viva voce; presentation; assignment |

*__POs__

PO (a): Engineering knowledge; PO(b): Problem analysis; PO (c): Design/development of solutions; PO(d): Investigation; PO(e) Modern tool use; PO(f): Engineer and society; PO(g): Environment and sustainability; PO(h): Ethics; PO(i): Individual work and teamwork; PO(j): Communication; PO(k): Project management and finance; PO(l): life-long learning

**__Domains__

**C-Cognitive** : C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

**A-Affective** : A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

**P-Psychomotor**: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

## 5. Lecture Plan

| wk | Lecture Topics | Corresponding CO(s) |
|---|---|---|
| 1 | • Crystalline and non-crystalline solids, single crystal and polycrystalline solids, unit cell, crystal systems<br>• Electric charge, Coulomb's Law, electric field, electric field lines, electric field due to a point charge, electric dipole, line of charge and charged disk, movement of charge in an electric field<br>• Frame of reference, Failure of Newtonian mechanics, Galilean transformation, Concept of Ether | CO1, CO2 |
| 2 | • Co-ordinations number, density and packing factor<br>• Flux - Gauss' law - application of Gauss' law: cylindrical, spherical and planar symmetry<br>• Michelson-Morley experiment, Consequence of Michelson-Morley experiment | CO1, CO2, CO3 |
| 3 | • Crystal planes and directions, Miller indices. | CO1, CO2, CO3 |

| wk | Lecture Topics | Corresponding CO(s) |
|---|---|---|
| | • Electric potential energy and electric potential, equipotential surface, calculating potential from the field<br>• Derivation of Lorentz transformation equations, Relativity of length, time and mass | |
| 4 | • Relation between interplanar spacing and Miller indices, mathematical problems related to crystal directions<br>• Potential due to a point charge and a group of point charges, potential due to continuous charge distribution, conductors in electrostatic equilibrium<br>• Mass-Energy relation, Relativistic addition of velocities, Relativity of simultaneity | CO1, CO2, CO3 |
| 5 | • Class test (Structure of matter)<br>• Capacitance - capacitors in series and in parallel - energy stored in an electric field - capacitors with dielectric<br>• Theory of light, Planck's quantum theory, Photo-electric effect, Characteristics (laws) of photoelectric emission | CO1, CO2, CO3 |
| 6 | • Crystal structures: NaCl, CsCl, etc<br>• Class Test (Electricity and Magnetism)<br>• Failure of wave theory of light to explain Photoelectric effect, Einstein photoelectric equation, Determination of Planck's constant, Light-matter interaction, Applications of photo-electric effect | CO1, CO2, CO3 |
| 7 | • Electric current, resistance and Ohm’s law - resistors in series and parallel - power in electric circuits - Kirchhoff’s laws and solving circuits - RC circuits<br>• Bragg's Law, Methods of determination of interplanar spacing from diffraction patterns, mathematical problems related to crystal structure analysis<br>• Compton effect, Compton theory, Wave particle duality/de-Broglie hypothesis, Determination of de-Broglie wavelength | CO1, CO2, CO3 |
| 8 | • Bonds in solids, interatomic distances<br>• Magnetic fields, Hall effect, Biot-savart law, torque on a current loop, magnetic dipole moment<br>• Limitation of Rutherford’s atom model, Postulates of the Bohr atomic model, Limitation of Bohr’s atom model, de-Broglie atom model | CO1, CO2, CO3 |
| 9 | • Calculation of cohesive and bonding energy; mathematical problems related to bonds in solids.<br>• Magnetic field due to a current, force between two parallel currents, Ampere’s law, solenoid<br>• Class Test (Modern physics) | CO1, CO2, CO3 |
| 10 | • Introduction to band theory<br>• Faraday’s law of induction, Lenz’s law, induction and energy transfer, induced electric field<br>• Properties of nucleus: Static nuclear properties and Dynamic properties, Mass defect, Binding energy, Binding energy per nucleon, Nuclear force | CO1, CO2, CO3 |
| 11 | • Distinction between metal, semiconductor, and insulator<br>• Inductors and inductance, self-induction, energy stored in a magnetic field, mutual induction, LR circuit<br>• Nuclear chain reactions, Different condition for nuclear chain reactions, Nuclear fission, Nuclear fusion, Little Boy: A gun-type bomb, Fat Man: Implosion-type bomb | CO1, CO2, CO3 |
| 12 | • Defects in solids, point defects<br>• Magnetic properties of matter, types of magnetic materials, application of magnetic materials<br>• Nuclear power reactor, Different parts of nuclear fission reactor, Types of fission reactor, Nuclear fusion reactor, Types of fusion reactor | CO1, CO2, CO3 |
| 13 | • Line defects, plane defects<br>• Hysteresis curve; Electromagnetic oscillation: L-C oscillations and its analogy to simple harmonic motion.<br>• Difficulties against using nuclear fusion, Nuclear models, The liquid drop model, Semi-empirical mass formula | CO1, CO2, CO3 |

| wk | Lecture Topics | Corresponding CO(s) |
|---|---|---|
| 14 | • Volume defects, consequences of defects and discussion based on application point of view.<br>• Mathematical problems related to magnetic field and magnetism<br>• The shell model, Radioactivity, Radioactive transformation, Decay law, Average life period of a radioelement | CO1, CO2, CO3 |

**6. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**7. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

**8. Textbook/ Reference**

3. Fundamentals of Physics; D. Halliday, R. Resnick, and J. Walker
4. Concepts of Modern Physics; Arthur Beiser
5. Modern Physics; Kenneth S. Krane
6. Introduction to Solid State Physics; C. Kittel
7. Solid State Physics; M. A. Wahab

Physics for Engineers - Part-2; Giasuddin Ahmad

## 20.70 Description of Course WRE 211

**Part-1: General Information**

| | |
|---|---|
| 1. **Course Number** | : WRE 211 |
| **Course Title** | : Fluid Mechanics |
| **Credit/Contact Hours** | : 3.0 (3 Hours/ Week) |
| 2. **Level and Term** | : Level-2, Term-2 |
| **Academic Term** | : |
| 3. **Type of Course** | : Departmental Core Course (Theory) |
| 4. **Pre-requisite Course(s)** | : None |
| 5. **Course Website** | : |
| 6. **Class Schedule** | : |
| 7. **Important Dates** | : For important dates and examination schedules and latest updates, please follow the course website. |

8. **Course Teachers**

**9. Consultation Time** :

**Part-2: Course Details**

| | |
|---|---|
| **10. Course Content** (As approved by the Academic Council) | Fluid properties; fluid statics; kinematics of fluid flows; fluid flow concepts and basic equations- continuity equation, Bernoulli's equation, energy equation, momentum equation and forces in fluid flow; steady incompressible flow in pressure conduits, laminar and turbulent flow, general equation for fluid friction; empirical equations for pipe flow; minor losses in pipe flow; pipe flow problems-pipes in series and parallel, branching pipes, pipe networks. |
| **11. Course Objectives** | To teach the students the different properties and governing laws of fluid flow and their applications in civil and water resources engineering. |
| **12. Student Learning Time** | 126 hours (Face-to-face – 42 hours, Independent/group learning – 84 hours) in 14 weeks |
| **13. Transferable Skills** | 1. Creative and critical thinking<br>2. Problem solving skill |
| **14. Knowledge Required** | Fundamental understanding of Physics, integral and differential calculus. |

### 15. Course Outcomes

| Course Learning Outcome (CO) | | Corresponding Program Outcomes, PO(s) * | Domains and Taxonomy level(s)** | Knowledge Profile (K) | Complex problem solving (P) | Complex Engineering activities (A) | Delivery Methods and Activity (ies) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| CO-1 | Ability to **identify** and **explain** the fundamental concepts and basic principle for fluid statics and dynamics | PO-1, PO-2 | C1, C2 | K1, K2 | -- | -- | Lectures, Tutorials | Assignment, Quiz, Final exam |
| CO-2 | Ability to **estimate** forces on different structures and to **apply** basic equations on a fluid system to **solve** real life problems | PO-1, PO-2, | C2, C3 | K2, K3 | -- | -- | Lectures, Tutorials | Assignment, Quiz, Final exam |
| CO-3 | Ability to **apply** physics of fluid flow to **estimate** the pipe losses and to **design** pipe network | PO-1, PO-2, PO-4 | C2, C3, C5 | K3, K5 | -- | -- | Lectures, Tutorials | Assignment, Quiz, Final exam |

***Programme Outcomes -PO (Outcomes of B.Sc. in WRE degree)**

PO-1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems in the field of water resources engineering and civil engineering.

PO-2: Problem analysis: Identify, formulate, research and analyze complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

PO-3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

PO-4: Investigation: Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

PO-5: Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

PO-6: The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO-7: Environment and sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO-8: Ethics: Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

PO-9: Individual work and teamwork: Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

PO-10: Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO-11: Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

PO-12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

---

*****The cognitive domain (C) and its Taxonomy Levels (1 to 6)*** *aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

| | | |
|---|---|---|
| ***C1- knowledge/remember;*** | ***C2-understand/explain/estimate;*** | ***C3-apply;*** |
| ***C4-analysis;*** | ***C5-synthesis/design/create/construct;*** | ***C6-evaluate/judge/verify*** |

---

### Knowledge Profile (K)

| | |
|---|---|
| ***K1*** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| ***K2*** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| ***K3*** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| ***K4*** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| ***K5*** | *Knowledge that supports engineering design in a practice area* |
| ***K6*** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |
| ***K7*** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| ***K8*** | *Engagement with selected knowledge in the research literature of the discipline* |

### Complex Problem Solving (P)

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***P1*** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |
| ***P2*** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| ***P3*** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| ***P4*** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| ***P5*** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| ***P6*** | *Extent of stakeholder involvement and level of conflicting requirements* | *Involve diverse groups of stakeholders with widely varying needs* |
| ***P7*** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

### Complex Engineering Activities (A)

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***A1*** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| ***A2*** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| ***A3*** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| ***A4*** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

## 16. Text Book:

- Fluid Mechanics with Engineering Applications (SI Metric Edition)
  ----- Robert L. Dauherty
  ----- Joseph B. Franzini
  ----- E. John Finnmore
- Fluid Mechanics
  ----- Victor L. Streeter
  ----- E. Benjamin Wylie

## 17. Lecture Schedule:

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Fluid Mechanics | Handout | CO-1 |
| 02 | Fluid Properties: Density, Specific gravity, surface tension, adhesion-cohesion, capillarity | Handout; Daugherty and Franzini Ch-1; Streeter Ch-1 | CO-1 |
| 03 | Fluid Properties: Viscosity and Rheological behaviour | Handout; Daugherty and Franzini Ch-1; Streeter Ch-1 | CO-1 |
| 04 | Problem Solving – Fluid Properties | Handout; Daugherty and Franzini Ch-3; Streeter Ch-3 | CO-1 |
| 05 | Fluid Statics: Pressure variation in static fluid | Handout; Daugherty and Franzini Ch-2; Streeter Ch-2 | CO-1<br>CO-2 |
| 06 | Measurement of pressure | Handout, Daugherty and Franzini Ch-2; Streeter Ch-2 | CO-1<br>CO-2 |
| 07 | Problem Solving – Pressure in static fluid | Handout, Daugherty and Franzini Ch-2; Streeter Ch-2 | CO-1<br>CO-2 |
| 08 | **CT 1** | | |
| 09 | Forces on inclined plane surface | Handout, Daugherty and Franzini Ch-2; Streeter Ch-2 | CO-1<br>CO-2 |
| 10 | Forces on curved surface | Handout, Daugherty and Franzini Ch-2; Streeter Ch-2 | CO-1<br>CO-2 |
| 11 | Buoyancy and stability of submerged and floating bodies | Handout, Daugherty and Franzini Ch-2; Streeter Ch-2 | CO-1<br>CO-2 |
| 12 | Fluid masses subjected to acceleration | Handout, Daugherty and Franzini Ch-2; Streeter Ch-2 | CO-1<br>CO-2 |
| 13 | Laminar and turbulent flow | Handout; Daugherty and Franzini Ch-8; Streeter Ch-10 | CO-3 |
| 14 | General equation for fluid friction, Empirical equations for pipe flow | Handout; Daugherty and Franzini Ch-8; Streeter Ch-10 | CO-3 |
| 15 | Problem Solving – Frictional losses in pipe flow | Handout; Daugherty and Franzini Ch-8; Streeter Ch-10 | CO-3 |
| 16 | Minor losses in pipe flow | Handout; Daugherty and Franzini Ch-8; Streeter Ch-10 | CO-3 |
| 17 | **CT 2** | | |
| 18 | Pipes in series and parallel, branching pipes | Handout; Daugherty and Franzini Ch-8; Streeter Ch-10 | CO-3 |
| 19 | Pipe networks | Handout; Daugherty and Franzini Ch-8; Streeter Ch-10 | CO-3 |

**Lecture Schedule (Section-B, 1.5 Cr. Hrs)**

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Fluid Mechanics: Concepts and Approaches | Handout | CO-1 |
| 02 | Kinematics of Fluid Flow | Handout; Daugherty and Franzini Ch-3; Streeter Ch-3 | CO-1 |
| 03 | Kinematics of Fluid Flow | Handout; Daugherty and Franzini Ch-3; Streeter Ch-3 | CO-1 |
| 04 | Flow Type and Continuity Equation | Handout; Daugherty and Franzini Ch-3; Streeter Ch-3 | CO-1<br>CO-2 |
| 05 | Bernoulli's Theorem | Handout; Daugherty and Franzini Ch-3; Streeter Ch-4 | CO-1<br>CO-2 |
| 06 | **CT-1** | | |
| 07 | Navier-Stokes Equation | Handout, | CO-1<br>CO-2 |
| 08 | Circular Flow and Energy Balance | Streeter Ch-3,4; Daugherty and Franzini Ch-3,4 | CO-1<br>CO-2 |
| 09 | Problem Solving - Energy Equation | Handout | CO-1<br>CO-2 |
| 10 | Pressure Difference in Curved Flow Path | Daugherty and Franzini Ch-3; Handout | CO-1<br>CO-2 |
| 11 | Momentum and Forces in Fluid Flow | Handout; Daugherty and Franzini Ch-6; Streeter Ch-5,6 | CO-1<br>CO-2 |
| 12 | **CT-2** | | |
| 13 | Momentum and Forces in Fluid Flow | Handout; Daugherty and Franzini Ch-6; Streeter Ch-5,6 | CO-1<br>CO-2 |
| 14 | Momentum and Forces in Fluid Flow | Handout; Daugherty and Franzini Ch-6; Streeter Ch-5,6 | CO-1<br>CO-2 |
| 15 | Momentum and Forces in Fluid Flow | Handout; Daugherty and Franzini Ch-6; Streeter Ch-5,6 | CO-1<br>CO-2 |
| 16 | Problem Solving - Momentum and Forces in Fluid Flow | Handout; Daugherty and Franzini Ch-6; Streeter Ch-5,6 | CO-1<br>CO-2 |
| 17 | Problem Solving - Momentum and Forces in Fluid Flow | Handout; Daugherty and Franzini Ch-6; Streeter Ch-5,6 | CO-1<br>CO-2 |
| 18 | Momentum and Forces in Fluid Flow-Propeller and Wind Turbine | Handout; Streeter Ch-6 | CO-1<br>CO-2 |
| 19 | Problem Solving - Momentum and Forces in Fluid Flow-Propeller and Wind Turbine | Handout; Streeter Ch-6 | CO-1<br>CO-2 |
| 20 | Turbomachines – Pumps, Turbines | Handout | CO-1<br>CO-2 |
| 21 | Overall discussions and review | | |

**18. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**19. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

## 20.71 Description of Course WRE 212

### Part-1: General Information

1. **Course Number** : WRE 212
   **Course Title** : Fluid Mechanics Sessional
   **Credit/Contact Hours** : 1.50 (3 Hours/ Week)
2. **Level and Term** : Level-2, Term-2
   **Academic Term** :
3. **Type of Course** : Departmental Core Course (Sessional)
4. **Pre-requisite Course(s)** : None
5. **Course Website** :
6. **Class Schedule** :
7. **Important Dates** : For important dates and examination schedules and latest updates, please follow the course website.
8. **Course Teachers**
9. **Consultation Time** :

### Part-2: Course Details

10. **Course Content** (As approved by the Academic Council)
    Center of pressure; proof of Bernoulli's theorem; flow through venturimeter; flow through orifice; coefficient of velocity by co-ordinate method; flow through mouthpiece; flow over V- notch; flow over sharp crested weir; fluid friction in pipe.
11. **Course Objectives**
    To teach the students the application of different fluid properties and governing laws and the application of different flow measuring devices.
12. **Student Learning Time**
    126 hours (Face-to-face – 42 hours, Independent/group learning – 84 hours) in 14 weeks
13. **Transferable Skills**
    1. Creative and critical thinking
    2. Problem solving skill
14. **Knowledge Required**
    Fundamental understanding of Physics, Integral and Differential Calculus.

## 15. Course Outcomes

| Course Learning Outcome (CO) | | Corresponding Program Outcomes, PO(s) * | Domains and Taxonomy Level** Cognitive Domain (C) | Knowledge Profile (K)*** | Complex problem solving (P)**** | Complex Engineering activities (A)***** | Delivery Method(s) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| CO-1 | **Apply** continuity, momentum, and energy equation on a fluid system. | PO-1, PO-2, PO-4 | C3 | K3 | -- | -- | Lectures, Hand-outs and Video Demonstration | Report writing, Quiz, Presentation, Viva |
| CO-2 | **Apply** basic principles of a fluid system to determine the performance of flow-measuring devices. | PO-1, PO-2, PO-4 | C3 | K3 | -- | -- | Lectures, Hand-outs and Video Demonstration | Report writing, Quiz, Presentation, Viva |
| CO-3 | **Apply** the laws of fluid flow for a pipe system and calculation of head loss for different conditions. | PO-1, PO-2, PO-4 | C3 | K3 | -- | -- | Lectures, Hand-outs and Video Demonstration | Report writing, Quiz, Presentation, Viva |

---

****Programme Outcomes -PO (Outcomes of B.Sc. in Water Resources Engineering degree)***

PO-1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems in the field of water resources engineering and civil engineering.

PO-2: Problem analysis: Identify, formulate, research and analyze complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

PO-3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

PO-4: Investigation: Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

PO-5: Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

PO-6: The engineer and society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO-7: Environment and sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO-8: Ethics: Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

PO-9: Individual work and teamwork: Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

PO-10: Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO-11: Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

PO-12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

## *Cognitive domain (C)*

---

*****The cognitive domain (C) and its Taxonomy Levels (1 to 6)** aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

***C1- knowledge/remember;*** ***C2-understand/explain/estimate;*** ***C3-apply;***

***C4-analysis;*** ***C5-synthesis/design/create/construct;*** ***C6-evaluate/judge/verify***

---

## ***Knowledge Profile (K)

| | |
|---|---|
| ***K1*** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| ***K2*** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| ***K3*** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| ***K4*** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| ***K5*** | *Knowledge that supports engineering design in a practice area* |
| ***K6*** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |
| ***K7*** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| ***K8*** | *Engagement with selected knowledge in the research literature of the discipline* |

## ****Complex Problem Solving (P)

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***P1*** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |
| ***P2*** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| ***P3*** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| ***P4*** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| ***P5*** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| ***P6*** | *Extent of stakeholder involvement and level* | *Involve diverse groups of stakeholders with widely varying needs* |

| | | |
|---|---|---|
| | *of conflicting requirements* | |
| ***P7*** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

## *****Complex Engineering Activities (A)

| | *Attribute* | *Complex Problems* |
|---|---|---|
| ***A1*** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| ***A2*** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| ***A3*** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| ***A4*** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

**16. Text Book:** WRE 212 Lab Manual

## 17. Lecture Schedule:

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Center of Pressure | Lab Manual, Hand-outs | CO1 |
| 02 | Bernoulli's Theorem | Lab Manual, Hand-outs | CO1 |
| 03 | Flow Through Venturimeter | Lab Manual, Hand-outs | CO2 |
| 04 | Flow Through Orifice | Lab Manual, Hand-outs | CO2 |
| 05 | Flow Through an External Cylindrical Mouthpiece | Lab Manual, Hand-outs | CO2 |
| 06 | **Mid-Quiz** | - | - |
| 07 | **Mid-Viva** | - | - |
| 08 | Flow over a Sharp Crested Weir | Lab Manual, Hand-outs | CO2 |
| 09 | Flow over a V-notch | Lab Manual, Hand-outs | CO2 |
| 10 | Fluid Friction in Pipe | Lab Manual, Hand-outs | CO3 |
| 11 | Head Loss due to Sudden Contraction and Sudden Expansion in a Pipe | Lab Manual, Hand-outs | CO3 |
| 12 | **Final-Quiz** | - | - |
| 13 | **Final-Viva** | - | - |

**18. Assessment Strategy**

1. Class Attendance – Class participation and attendance will be recorded in every class
2. Daily Assessment– Daily Assessment may be in the form of laboratory performance, report writing and submission, short class test, VIVA etc.
3. Mid Quiz and Final Quiz – Two comprehensive written examinations which will be declared at least one week before occurrence

**19. Distribution of Marks**

1. Class Participation-10%,
2. Quiz/Assignments-30%,
3. Presentation and Viva-30%,
4. Report writing- 30%.

## 20.72 Description of Course WRE 311

### Part-1: General Information

| | | |
|---|---|---|
| 1. | **Course Number** | WRE 311 |
| | **Course Title** | Open Channel Hydraulics |
| | **Credit/Contact Hours** | 4.00 |
| 2. | **Level and Term** | Level-3, Term-1 |
| | **Academic Term** | July 2021 |
| 3. | **Type of Course** | Required Course |
| 4. | **Pre-requisite Course(s)** | WRE211 |
| 5. | **Course Website (Part-A)** | *https://teams.microsoft.com/l/team/19%3aq4XtxBg2e_8ly1vVOYZnE5fYJBUHFNG_GAZp8bykIk41%40thread.tacv2/conversations?groupId=3aaf1dc3-c56d-4e44-b2d4-d8ffa31eac17&tenantId=79a50cb4-fa04-495b-9bd1-7860bc00fe6a* |
| 6. | **Lecture Schedule** | Part-A: Sun (08:00 am –08:50 am), Mon (09:00 am –9:50 am) |
| 7. | **Important Dates** | For important dates and examination schedules and latest updates, please follow the course website. |
| 8. | **Course Teachers** | (Part-A, 2 Cr. Hrs)<br>Mrs Sara Ferdousi<br>Asst. Professor, Department of WRE, BUET<br>email: sara@wre.buet.ac.bd<br><br>(Part-B, 2 Cr. Hrs)<br>Dr. K. M.Ahtesham Hossain<br>Asst. Professor, Department of WRE, BUET<br>email: ahtesham@wre.buet.ac.bd |
| 9. | **Consultation Time** | Tuesday (11:00 am –1:00 pm) |

### Part-2: Course Details

**10. Course Content** (As approved by the Academic Council)

Open channel flow and its classification; velocity and pressure distributions; energy equation, specific energy and transition problems; critical flow and control; principles of flow measurement devices; concept of uniform flow, Chezy and Manning equations, estimation of resistance coefficients and computation of uniform flow; momentum equation and specific momentum; hydraulic jump theory and analysis of gradually varied flow; computation of flow profiles; design of channels. Hydraulics of bridge and culvert

**11. Course Objectives**

1. Enable students to understand and apply the fundamental principles governing open channel hydraulics to the design of engineering systems.
2. To teach students how open channel flow varies with space and time (uniform, non-uniform, steady, gradually varied, rapidly varied flow,)
3. To teach the students the fundamental laws of mechanics (conservation of mass, momentum and energy) to a wide variety of flows

4. To teach the students the concept of uniform flow, specific energy and critical flow, gradually varied flow and their computation
5. To teach the students the different methods for computation of flow profiles
6. To teach students the hydraulics around bridge and culverts
7. To teach the students the different methods to design lined and unlined channels

**12. Student Learning Time**

164 hours (Face-to-face – 84 hours, Independent/group learning – 80 hours)

**13. Transferable Skills**

1. Creative and critical thinking
2. Problem solving skill, planning and design skill

**14. Knowledge Required**

Familiarity with the basic principles of mathematics, science and engineering

**15. Course Outcomes**

| Course Learning Outcome (CO) | | Corresponding Program Outcomes, PO(s)* | Domains and Taxonomy Level** Congnitive Domain (C) | Knowledge Profile (K)*** | Complex problem solving (P)**** | Complex Engineering activities (A)***** | Delivery Method(s) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| CO-1 | Ability to ***explain*** and ***apply*** fundamental concepts, techniques, and engineering knowledge used in open channel Hydraulics | PO-1<br>PO-2 | C1, C4 | K1, K3 | P2, P3, P6 | | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| CO-2 | ***Apply*** continuity, momentum and energy equation on open channel flow system and ***solve*** real life problems | PO-1,<br>PO-2,<br>PO-3 | C3 | K2 | | | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| CO-3 | Ability to *explain* the theories of uniform flow, gradually varied flow, critical flow and *identify* different flow profiles in channels | PO-1<br>PO-2 | C2<br>C5 | K1, K3 | P2, P3 | A2, A3 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| CO-4 | ***Perform*** hydraulic analysis and ***design*** of lined and unlined channels | PO-1,<br>PO-2,<br>PO-3,<br>PO-12 | C2<br>C6 | K4, K5, K6 | | A4 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |

## *Programme Outcomes -PO (Outcomes of B.Sc. in Civil Engineering degree)

PO-1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO-2: **Problem analysis:** Identify, formulate, research and analyse complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

PO-3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

PO-4: **Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

PO-5: **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

PO-6: **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO-7: **Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO-8: **Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

PO-9: **Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

PO-10: **Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO- 11: **Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

PO- 12: **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

## Cognitive Domain (C)

---

***__The cognitive domain (C) and its Taxonomy Levels (1 to 6)__ aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

| | | |
|---|---|---|
| ***C1- knowledge/remember;*** | ***C2-understand/explain/estimate;*** | ***C3-apply;*** |
| ***C4-analysis;*** | ***C5-synthesis/design/create/construct;*** | ***C6-evaluate/judge/verify*** |

---

### ***Knowledge Profile (K)

| | |
|---|---|
| ***K1*** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| ***K2*** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| ***K3*** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| ***K4*** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| ***K5*** | *Knowledge that supports engineering design in a practice area* |
| ***K6*** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |
| ***K7*** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| ***K8*** | *Engagement with selected knowledge in the research literature of the discipline* |

### ****Complex Problem Solving (P)

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***P1*** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |
| ***P2*** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| ***P3*** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| ***P4*** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| ***P5*** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| ***P6*** | *Extent of stakeholder involvement and level of conflicting requirements* | *Involve diverse groups of stakeholders with widely varying needs* |
| ***P7*** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

### *****Complex Engineering Activities (A)

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***A1*** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| ***A2*** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| ***A3*** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| ***A4*** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

## 16. Text Book/Reference Reading Materials:

1. Ven Te Chow, 1959. Open channel Hydraulics
2. Chaundhury, M.H. 2008, Open Channel Flow, 2nd Edition
3. Yunus Cengel and John Cimbala, Fluid Mechanics Fundamentals and Applications , 3rd Edition

## 17. Lecture Schedule (Part-A, 2 Cr. Hrs)

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Open Channel Flow | Handout; Ven Te Chow Ch-1; Yunus et al Ch-13 | CO-1 |
| 02 | Geometric elements of different channel sections | Handout; Ven Te Chow Ch-1; Yunus et al Ch-13 | CO-1 |
| 03 | Effect of viscosity and gravity on Open Channel Flow and determining the state of floe | Handout; Ven Te Chow Ch-1; Yunus et al Ch-13 | CO-1 |
| 04 | Problem Solving – state of flow | Handout; Ven Te Chow Ch-1; Yunus et al Ch-13 | CO-1 |
| 05 | Velocity distribution in an open channel flow | Handout; Ven Te Chow Ch-2; Yunus et al Ch-13 | CO-1 |
| 06 | Problem Solving – calculating mean velocity using area velocity method | Handout; Ven Te Chow Ch-2; Yunus et al Ch-13 | CO-1 |
| 07 | Velocity distribution coefficients | Handout; Ven Te Chow Ch-2; Yunus et al Ch-13 | CO-1 |
| 08 | Pressure distribution in Open channel flow | Handout; Ven Te Chow Ch-2; Yunus et al Ch-13 | CO-1 |
| 09 | **CT 1: velocity and pressure distribution in open channel flows** | | |
| 10 | Specific Energy and critical flow | Handout; Ven Te Chow Ch-3: Yunus et al Ch-13 | CO-2<br>CO-3<br>CO-4 |
| 11 | Characteristics of Specific Energy curve | Handout; Ven Te Chow Ch-3: Yunus et al Ch-13 | CO-2<br>CO-3 |
| 12 | Critical depth for different channel cross section | Handout; Ven Te Chow Ch-4: Yunus et al Ch-13 | CO-2<br>CO-3 |
| 13 | Numerical methods for calculating critical depth | Handout; Ven Te Chow Ch-4: Yunus et al Ch-13 | CO-2<br>CO-3 |
| 14 | Section factor and hydraulic exponent for critical flow | Handout; Ven Te Chow Ch-4: Yunus et al Ch-13 | CO-2<br>CO-3 |
| 15 | Transitions by change in channel bed | Handout; Ven Te Chow Ch-4: Yunus et al Ch-13 | CO-1<br>CO-2<br>CO-3 |
| 16 | Transitions by change in channel width | Handout; Ven Te Chow Ch-4: Yunus et al Ch-13 | CO-1<br>CO-2<br>CO-3 |
| 17 | Flow measuring devices | Handout; Ven Te Chow Ch-4: Yunus et al Ch-13 | CO-1<br>CO-2<br>CO-3 |
| 18 | **CT 2: critical flow and transitions** | | CO-1<br>CO-3 |
| 19 | Hydraulic jump and its classification | Handout; Ven Te Chow Ch-15: Yunus et al Ch-13 | CO-1<br>CO-2 |
| 20 | Principle of momentum and specific force | Handout; Ven Te Chow Ch-15: Yunus et al Ch-13 | CO-1<br>CO-2 |
| 21 | Sequent depths of hydraulic jump | Handout; Ven Te Chow Ch-15: Yunus et al Ch-13 | CO-1<br>CO-2 |

| | | | |
|---|---|---|---|
| 22 | Characteristics of hydraulic jump | Handout; Ven Te Chow Ch-15: Yunus et al Ch-13 | CO-1 CO-2 |
| 23 | Submerged jump and stilling basin | Handout; Ven Te Chow Ch-15: Yunus et al Ch-13 | CO-1 CO-2 |
| 24 | Design of a stilling basin | Handout; Ven Te Chow Ch-15: Yunus et al Ch-13 | CO-1 CO-4 |
| 25 | **CT 3: Hydraulic Jump** | | CO-1 CO-2 CO-4 |
| 26 | Design of rigid boundary channel using the best hydraulic section | Handout; Ven Te Chow Ch-7: Yunus et al Ch-13 | CO-1 CO-4 |
| 27 | Design of mobile boundary channel by tractive force method | Handout; Ven Te Chow Ch-7: Yunus et al Ch-13 | CO-1 CO-4 |
| 28 | Design of alluvium channel by Lacey's approach | Handout; Ven Te Chow Ch-7: Yunus et al Ch-13 | CO-1 CO-4 |

### Lecture Schedule (Part-B, 2 Cr. Hr.)

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Open Channel Flow Course | Class lecture and Handout | |
| 02 | Concept of Open Channel Flow | Class lecture and Handout | CO1 |
| 03 | Classification of Open Channel Flow | Class lecture and Handout | CO1 |
| 04 | Basic equations for steady 1-D flow and their applications | Class lecture and Handout | CO2, CO4 |
| 05 | Concept of uniform flow | Class lecture and Handout | CO3 |
| 06 | Chezy and Manning equations, Estimation of resistance coefficients | Class lecture and Handout | CO3 |
| | **Quiz-1** | | |
| 07 | Computation of normal depth (analytical method) | Class lecture and Handout | CO2, CO3 |
| 08 | Computation of normal depth (trial and error method) | Class lecture and Handout | CO2, CO3 |
| 09 | Computation of normal depth (numerical method) | Class lecture and Handout | CO2, CO3 |
| 10 | Computation of normal and critical slope | Class lecture and Handout | CO3 |
| 11 | Composite roughness and compound cross-section | Class lecture and Handout | CO3 |
| 12 | Computation of flood discharge by slope-area method | Class lecture and Handout | CO2, CO3 |
| 13 | Theory and basic equations of Gradually Varied Flow | Class lecture and Handout | CO4 |
| 14 | Characteristics and classification of gradually varied flow | Class lecture and Handout | CO4 |
| 15 | Flow profiles in mild, critical and steep sloped channel | Class lecture and Handout | CO4, CO5 |
| 16 | Flow profiles in adverse and horizontal sloped channel | Class lecture and Handout | CO4, CO5 |
| 17 | Flow profiles in serial arrangements of channels | Class lecture and Handout | CO5 |
| | **Quiz-2** | | |
| 18 | Flow profiles in serial arrangements of channels (continued) | Class lecture and Handout | CO5 |
| 19 | Computation of flow profiles in wide and horizontal channels by Direct Integration method | Class lecture and Handout | CO5 |
| 20 | Computation of flow profiles by Direct Step method | Class lecture and Handout | CO5 |
| 21 | Computation of flow profiles by Standard Step method | Class lecture and Handout | CO5 |

| | | | |
|---|---|---|---|
| 22 | Computation of flow profiles by Standard Step method (continued) | Class lecture and Handout | CO5 |
| 23 | Computation of flow profiles by Numerical method | Class lecture and Handout | CO5 |
| 24 | Principles of flow measurement | Class lecture and Handout | CO6 |
| 25 | Devices used for flow measurement | Class lecture and Handout | CO6 |
| 26 | Course review | - | - |

**18. Assessment Strategy**

1. Class Attendance – Class participation and attendance will be recorded in every class
2. Quiz – Quiz may in the form of class test, assignment, presentation etc, which will be declared at least one week before such assessment.
3. Final Examination – A comprehensive term final examination will be held at the end of the Term following the guideline of the Academic Council.

**19. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

## 20.73 Description of Course WRE 312

### Part-1: General Information

| | | |
|---|---|---|
| **1.** | **Course Number** | WRE 312 |
| | **Course Title** | Open Channel Flow Sessional |
| | **Credit/Contact Hours** | 1.50 (3.00 Hours/ Week) |
| **2.** | **Level and Term** | Level-3, Term-2 |
| | **Academic Term** | |
| **3.** | **Type of Course** | Departmental Core Sessional Course |
| **4.** | **Pre-requisite Course(s)** | N/A |
| **5.** | **Course Website** | |
| **6.** | **Lecture Schedule** | |
| **7.** | **Important Dates** | For important dates and examination schedules and latest updates, please follow the course website. |
| **8.** | **Course Teachers** | |
| **9.** | **Consultation Time** | |

**Part-2: Course Details**

| | |
|---|---|
| **10. Course Content** (As approved by the Academic Council) | Broad-crested weir; sluice gate; venturi flume; Parshall flume; cutthroat flume; hydraulic jump; velocity distribution profile; Manning's roughness coefficient; specific force and specific energy. |
| **11. Course Objectives** | The objective of the course is to acquaint the students with different flow measuring devices, measurement techniques and their applications in open channels. |
| **12. Student Learning Time** | 84 hours (Face-to-face – 42 hours, Independent/group learning – 42 hours) |
| **13. Transferable Skills** | 1. Principles of different flow measuring devices<br>2. Applications to the field |
| **14. Knowledge Required** | Basic theory of open channel flow. |

**15. Course Outcomes**

| Course Learning Outcome (CO) | | Corresponding Program Outcomes, PO(s) * | Domains and Taxonomy Level** Cognitive Domain (C) | Knowledge Profile (K)*** | Complex problem solving (P)**** | Complex Engineering activities (A)***** | Delivery Method(s) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| CO-1 | Ability to *understand* the operating principles and usages of different flow measuring devices in open channels | PO-1, PO-5 | C1, C2 | K1, K3 | | | Lectures, Tutorials, Experimental demonstration | Assignment, Quiz, Report, Viva |
| CO-2 | Ability to *estimate* different flow characteristics (force, energy and momentum) in open channels | PO-1, PO-2 | C2, C5 | K3 | | | Lectures, Tutorials, Experimental demonstration | Assignment, Quiz, Report, Viva |

***Programme Outcomes -PO (Outcomes of B.Sc. in Civil Engineering Degree)**

Program Outcomes (POs) are narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills and attitudes that students acquire while progressing through the program. The following are the program outcomes for the **B. Sc. in Civil Engineering** program:

**PO1-Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems in the field of water resources engineering and civil engineering.

**PO2-Problem analysis:** Identify, formulate, research and analyse complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

**PO3-Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

**PO4-Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

**PO5-Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of their limitations.

**PO6-The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

**PO7-Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

**PO8-Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

**PO9-Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

**PO10-Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

**PO11-Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

**PO12-Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

All twelve POs that are adopted for the civil engineering program are mandatory requirements as per the BAETE guideline. No additional PO is adopted for the program.

---

****Cognitive domain (C)**

***The cognitive domain (C) and its Taxonomy Levels (1 to 6)*** *aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

***C1**- knowledge/remember;* ***C2**-understand/explain/estimate;* ***C3**-apply;*

***C4**-analysis;* ***C5**-synthesis/design/create/construct;* ***C6**-evaluate/judge/verify*

*****Knowledge Profile (K)**

| | |
|---|---|
| ***K1*** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| ***K2*** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| ***K3*** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| ***K4*** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| ***K5*** | *Knowledge that supports engineering design in a practice area* |
| ***K6*** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |
| ***K7*** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| ***K8*** | *Engagement with selected knowledge in the research literature of the discipline* |

******Complex Problem Solving (P)**

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***P1*** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |

| | | |
|---|---|---|
| ***P2*** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| ***P3*** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| ***P4*** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| ***P5*** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| ***P6*** | *Extent of stakeholder involvement and level of conflicting requirements* | *Involve diverse groups of stakeholders with widely varying needs* |
| ***P7*** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

*******Complex Engineering Activities (A)**

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***A1*** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| ***A2*** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| ***A3*** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| ***A4*** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

## 16. Text Book/Reference Reading Materials:

1. "Open Channel Hydraulics" by Ven Te Chow.
2. "Open Channel Hydraulics" by Richard H. French
3. "Lab Manual on Open Channel Hydraulics Sessional"
4. "Open Channel Flow" by F.M. Henderson
5. "Lecture Note on Open Channel Flow" by Dr. Md. Abdul Halim

## 17. Lecture Schedule

| Week No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Experiment 1: Determination of State of flow in Open Channel | Lab manual, Chow/Ch-1,4, French/Ch-1 | CO1 |
| 02 | Experiment 2: Flow Over a Broad Crested Weir | Lab manual, French/Ch-8, Franzini/Ch-12 | CO1 |
| 03 | Experiment 3: Flow Through a Venturi Flume | Lab manual, French/Ch-8 | CO1 |
| 04 | Experiment 4: Flow Through a Parshall Flume | Lab manual, French/Ch-8, Chow/Ch-4, Michael/Ch-4 | CO1 |
| 05 | Experiment 5: Flow Through a Cut- throat Flume | Lab manual, Michael/Ch-4 | CO1 |
| 06 | Experiment 6: Flow Beneath a Sluice Gate | Lab manual, Henderson/Ch-6 | CO1 |
| 07 | Viva | | |

| | | | |
|---|---|---|---|
| 08 | **Mid Quiz** | - | - |
| 09 | Experiment 7: Hydraulic Jump | Lab manual, Chow/Ch-15 | CO1, CO2 |
| 10 | Experiment 8: Development of Generalized Specific Energy and Specific Force Curves | Lab manual, Chow/Ch-3 | CO1, CO2 |
| 11 | Experiment 9: Velocity Distribution Profile in Laboratory Flume | Lab manual, Chow/Ch-2,8 | CO1, CO2 |
| 12 | Experiment 10: Measurement of Discharge using Area- Velocity Method | Lab manual, Chow/Ch-2,8 | CO1, CO2 |
| 13 | **Final Quiz** | - | - |
| 14 | Viva, Submission of repot | - | - |

**18. Assessment Strategy**

1. Class Participation – Class participation and attendance will be recorded in every class
2. Report-Students will submit report for each experiment.
3. Quiz – Quiz will be in the form of written test.
4. Viva- Student will have to face a viva board at the end of the sessional course.

**19. Distribution of Marks**

1. Attendance and Class Participation-10%, 2. Class Work/Repot/Assignment-45%, 3. Quiz(s)-35%, 4. Viva-10%

## 20.74 Description of Course WRE 409

### Part-1: General Information

| | | |
|---|---|---|
| 1. | Course Number | WRE 409 |
| | Course Title | River Engineering |
| | Credit/Contact Hours | 2.00 |
| 2. | Level and Term | Level-4, Term-2 |
| | Academic Term | |
| 3. | Type of Course | |
| 4. | Pre-requisite Course(s) | None |
| 5. | Course Website (Part-A) | |
| 6. | Lecture Schedule | |
| 7. | Important Dates | For important dates and examination schedules and latest updates, please follow the course website. |
| 8. | Course Teachers | |
| 9. | Consultation Time | |

**Part-2: Course Details**

| | |
|---|---|
| **10. Course Content** (As approved by the Academic Council) | Behaviour of alluvial rivers; River channel pattern and fluvial processes; bed forms and flow regimes; Aggradation and degradation; local scours; river training and bank protection works; Navigation and dredging; Sediment movement in river channels. |
| **11. Course Objectives** | To acquaint the students with river morphology. This course will also teach them the functions and design of various river training and bank protection works. |
| **12. Student Learning Time** | 84 hours (Face-to-face – 28 hours, Independent/group learning – 56 hours) |
| **13. Transferable Skills** | 1. Creative and critical thinking<br>2. Problem solving skill, planning and design skill |
| **14. Knowledge Required** | Familiarity with Open Channel Hydraulics. |

**15. Course Outcomes**

| Course Learning Outcome (CO) | | Corresponding Program Outcomes, PO(s) * | Domains and Taxonomy Level** Cognitive Domain (C) | Knowledge Profile (K)*** | Complex problem solving (P)**** | Complex Engineering activities (A)***** | Delivery Method(s) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| 1 | Ability to *explain* behaviour of alluvial rivers, fluvial processes and sediment transport mechanics. | PO-1 | C1, C2 | K1, K4 | - | - | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| 2 | Ability to *describe* aggradation and degradation processes, navigation and dredging techniques. | PO-1 | C1, C2 | K1, K4 | - | - | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| 3 | Ability to *design* various river training and bank protection works. | PO-1, PO-2, PO-3 | C3, C4, C5 | K4, K5 | P2 | - | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| 4 | Ability to *apply* scour formulae and *estimate* scour depth for hydraulic structures i.e. bridges. | PO-2, PO-3 | C3, C4 | K4, K5 | P2 | - | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |

***Programme Outcomes -PO (Outcomes of B.Sc. in Civil Engineering degree)**

**PO1- Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**PO2- Problem analysis:** Identify, formulate, research and analyse complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

**PO3- Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

**PO4- Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

**PO5- Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of their limitations.

**PO6- The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

**PO7- Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

**PO8-Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

**PO9- Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

**PO10- Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

**PO11- Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

**PO12- Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

All twelve POs that are adopted for the civil engineering program are mandatory requirements as per the BAETE guideline. No additional PO is adopted for the program.

---

****Cognitive domain (C)**

***The cognitive domain (C) and its Taxonomy Levels (1 to 6)*** *aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

| | | |
|---|---|---|
| ***C1**- knowledge/remember;* | ***C2**-understand/explain/estimate;* | ***C3**-apply;* |
| ***C4**-analysis;* | ***C5**-synthesis/design/create/construct;* | ***C6**-evaluate/judge/verify* |

*****Knowledge Profile (K)**

| | |
|---|---|
| ***K1*** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| ***K2*** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| ***K3*** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| ***K4*** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| ***K5*** | *Knowledge that supports engineering design in a practice area* |
| ***K6*** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |
| ***K7*** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| ***K8*** | *Engagement with selected knowledge in the research literature of the discipline* |

******Complex Problem Solving (P)**

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***P1*** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |
| ***P2*** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| ***P3*** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| ***P4*** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| ***P5*** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| ***P6*** | *Extent of stakeholder involvement and level of conflicting requirements* | *Involve diverse groups of stakeholders with widely varying needs* |
| ***P7*** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

*******Complex Engineering Activities (A)**

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***A1*** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| ***A2*** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| ***A3*** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| ***A4*** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

## 16. Text Book/Reference Reading Materials:

1. “Fluvial Processes in River Engineering” by Howard H. Chang
2. “Irrigation Engineering and Hydraulic Structures” by Santosh Kumar Garg
3. “River Geomorphology” by Edward J. Hickin
4. “Hydraulic Reference Manual of HEC-RAS” by US Army Corps of Engineers (Version 5.0, February 2016)
5. “River Mechanics” by Pierre Y. Julien
6. “River Engineering” by K.D. Gupta

## 17. Lecture Schedule (Part-A, 1.0 Cr. Hrs)

| Week No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Rivers of Bangladesh and River Engineering | Handout | CO1 |
| 02 | River Training and Bank Protection works | Handout | CO3 |
| 03 | River Training and Bank Protection works | S.K. Garg/Ch-8 | |
| 04 | River Training and Bank Protection works | S.K. Garg/Ch-8 | |
| 05 | **Quiz 1** | - | - |
| 06 | River Training and Bank Protection works | Handout | CO3 |
| 07 | Sediment Movements in River Channel | H. Chang; Hickin | CO2 |
| 08 | Sediment Movements in River Channel | H. Chang; Hickin | |
| 09 | **Quiz 2** | - | - |
| 10 | Local Scour | HEC-RAS Reference Manual, US Army | CO4 |
| 11 | Local Scour | Handout | |
| 12 | Navigation and Dredging | Handout | CO2 |
| 13 | Course Review | - | - |

## Lecture Schedule (Part-B, 1.0 Cr. Hrs)

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction | Lecture material | CO1 |
| 02 | Behaviour of alluvial rivers | Chang/Ch-1 | |
| 03 | Behaviour of alluvial rivers | Lecture material | |
| 04 | River channel pattern and fluvial processes | Chang/Ch-2 | |
| 05 | River channel pattern and fluvial processes | Lecture material | |
| 06 | River channel pattern and fluvial processes | Chang/Ch-2 | |
| 07 | **Quiz-1** | - | - |
| 08 | Bed form and flow regimes | Chang/Ch-9 | CO2 |
| 09 | Bed form and flow regimes | Lecture material | |
| 10 | Aggradation and degradation | Lecture material | |
| 11 | Aggradation and degradation | Lecture material | |
| 12 | **Quiz-2** | - | - |
| 13 | Class Review | - | - |

## 18. Assessment Strategy

1. Class Attendance – Class participation and attendance will be recorded in every class
2. Quiz – Quiz may in the form of class test, assignment, presentation etc, which will be declared at least one week before such assessment.

3. Final Examination – A comprehensive term final examination will be held at the end of the Term following the guideline of the Academic Council.

**19. Distribution of Marks** 1. Class Participation-10%, 2. Quiz/CT/Assignments-20%, 3.Fnal Examination-70%

## 20.75 Description of Course WRE 411

### Part-1: General Information

| | |
|---|---|
| **1. Course Number** | WRE 411 |
| **Course Title** | Hydraulic Structures |
| **Credit/Contact Hours** | 2.00 |
| **2. Level and Term** | Level-4, Term-2 |
| **Academic Term** | |
| **3. Type of Course** | Required Course |
| **4. Pre-requisite Course(s)** | None |
| **5. Course Website** | |
| **6. Lecture Schedule** | |
| **7. Important Dates** | For important dates and examination schedules and latest updates, please follow the course website (Teams). |
| **8. Course Teachers** | |
| **9. Consultation Time** | |

### Part-2: Course Details

| | |
|---|---|
| **10. Course Content** (As approved by the Academic Council) | Principles of design of hydraulic structures; types of hydraulic structures; design of dams; design of barrages, weirs; design of spillways, energy dissipators and spillway gates; cross drainage works. |
| **11. Course Objectives** | The objective of the course is to teach the students about the types, functions, planning and design principles of hydraulic structures. |
| **12. Student Learning Time** | 84 hours (Face-to-face – 28 hours, Independent/group learning – 56 hours) |
| **13. Transferable Skills** | 1. Critical thinking.<br>2. Problem solving skill, planning and design skill |
| **14. Knowledge Required** | Familiarity with hydraulics, hydrology, and analytical mechanics. |

## 15. Course Outcomes

| Course Learning Outcome (CO) | | Corresponding Program Outcomes, PO(s)* | Domains and Taxonomy Level** Cognitive Domain (C) | Knowledge Profile (K)*** | Complex problem solving (P)**** | Complex Engineering activities (A)***** | Delivery Method(s) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| CO-1 | Ability to *outline* the features, characteristics and functions of different types of hydraulic structures | PO-2 | C1, C4 | K1 | | | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| CO-2 | Ability to *explain* the basic principles of designing hydraulics structures | PO-1, PO-4 | C2, C5, C6 | K2 | | | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| CO-3 | Ability to *plan* the site of a dam reservoir | PO-3 | C5 | K2, K3 | P1, P6 | A2, A4 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| CO-4 | Ability to *design* different types of hydraulic structures: barrage, weir, regulator, dam, spillway, cross-drainage works etc. | PO-1, PO-4, PO-12 | C5 | K4, K5, K6 | | A4 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |

***Programme Outcomes -PO (Outcomes of B.Sc. in Civil Engineering degree)**

PO-1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO-2: **Problem analysis:** Identify, formulate, research and analyse complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

PO-3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

PO-4: **Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

PO-5: **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

PO-6: **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO-7: **Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO-8: **Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

PO-9: **Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

PO-10: **Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO- 11: **Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

PO- 12: **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

****Cognitive Domain (C)**

******The cognitive domain (C) and its Taxonomy Levels (1 to 6)*** *aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

| | | |
|---|---|---|
| ***C1- knowledge/remember;*** | ***C2-understand/explain/estimate;*** | ***C3-apply;*** |
| ***C4-analysis;*** | ***C5-synthesis/design/create/construct;*** | ***C6-evaluate/judge/verify*** |

*****Knowledge Profile (K)**

| | |
|---|---|
| ***K1*** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| ***K2*** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| ***K3*** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| ***K4*** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| ***K5*** | *Knowledge that supports engineering design in a practice area* |
| ***K6*** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |
| ***K7*** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| ***K8*** | *Engagement with selected knowledge in the research literature of the discipline* |

******Complex Problem Solving (P)**

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| ***P1*** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |
| ***P2*** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| ***P3*** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| ***P4*** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| ***P5*** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| ***P6*** | *Extent of stakeholder involvement and level of conflicting requirements* | *Involve diverse groups of stakeholders with widely varying needs* |
| ***P7*** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

*******Complex Engineering Activities (A)**

| | *Attribute* | *Complex Problems* |
|---|---|---|
| ***A1*** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| ***A2*** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| ***A3*** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| ***A4*** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

## 16. Text Book/Reference Reading Materials:

1. "Irrigation Engineering and Hydraulic Structures", Author: Santosh Kumar Garg.

## 17. Lecture Schedule (Part-A, 1 Cr. Hrs)

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Hydraulic Structures | Handout | CO1 |
| 02 | Introduction to Dams. | Garg/Ch- 17 | CO1 |
| 03 | Reservoirs and planning of Dam Reservoirs | Garg/Ch- 18 | CO2, CO3 |
| 04 | Reservoirs and planning of Dam Reservoirs | Garg/Ch- 18 | CO2, CO3 |
| 05 | Design and construction of gravity dam | Garg/Ch- 19 | CO4 |
| 06 | Design and construction of gravity dam | Garg/Ch- 19 | |
| 07 | Design and construction of gravity dam | Garg/Ch- 19 | |
| 08 | **Class Test-1** | | - |
| 09 | Design of spillways | Garg/Ch- 21 | CO4 |
| 10 | Design of spillways | Garg/Ch- 21 | |
| 11 | Energy dissipators and spillway gates | Garg/Ch- 21 | |
| 12 | **Class Test-2** | | - |
| 13 | Course review | - | - |

## Lecture Schedule (Part-B, 1 Cr. Hrs)

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Hydraulic Structures of Bangladesh | Handout | CO1 |
| 02 | Types of Hydraulic Structures | Handout | |
| 03 | Principles of design of hydraulic structures: Theories of Seepage | Garg/Ch-11 | CO1, CO2 |
| 04 | Theories of Seepage: Khosla's Theory (Problem Solving) | Garg/Ch-11 | |
| 05 | Design of Modern Weirs Founded on Permeable Foundations on the basis of Khosla's Theory | Garg/Ch-11 | CO4 |
| 06 | Design of Modern Weirs Founded on Permeable Foundations on the basis of Khosla's Theory (Continued) | Garg/Ch-11 | |
| 07 | **QUIZ-1,** Theories of Seepage and Design of Weirs | Garg/Ch-11 | - |
| 08 | Design of Modern Barrages Founded on Permeable Foundations on the basis of Khosla's Theory | Garg/Ch-11 | CO4 |

| | | | |
|---|---|---|---|
| 09 | Design of Modern Barrages Founded on Permeable Foundations on the basis of Khosla's Theory (Continued) | Garg/Ch-11 | |
| 10 | Introduction to Cross Drainage Works: Types and Features, Selection of a Suitable Type of Cross Drainage Work and Design Considerations | Garg/Ch-14 | |
| 11 | Designing a Cross Drainage Work (Example Problem) | Garg/Ch-14 | |
| 12 | **QUIZ-2,** Cross Drainage Works | Garg/Ch-14 | |
| 13 | Course review | - | - |

**18. Assessment Strategy**

1. Class Attendance – Class participation and attendance will be recorded in every class
2. Quiz – Quiz may in the form of class test, assignment, presentation etc., which will be declared at least one week before such assessment.
3. Final Examination – A comprehensive term final examination will be held at the end of the Term following the guideline of the Academic Council.

**19. Distribution of Marks**

1. Class Participation: 10%, 2. Quiz/CT/Assignments: 20%, 3. Final Examination: 70%

## 20.76 Description of Course WRE 412

### Part-1: General Information

**1. Course Number** WRE 412

**Course Title** Water Resources Engineering Sessional

**Credit/Contact Hours** 1.50 (3 Hours/ Week)

**2. Level and Term** Level-4, Term-2

**Academic Term**

**3. Type of Course** Required Course

**4. Pre-requisite Course(s)** None

**5. Course Website**

**6. Lecture Schedule**

**7. Important Dates** For important dates and examination schedules and latest updates, please follow the course website.

**8. Course Teachers**

**9. Consultation Time**

**Part-2: Course Details**

| | |
|---|---|
| **10. Course Content** (As approved by the Academic Council) | Design of hydraulic structures, river training works, Groundwater resource assessment and water well design. |
| **11. Course Objectives** | To acquaint the students with different types of hydraulic structures and to teach them the hydrologic, hydraulic and structural design of a hydraulic structure. |
| **12. Student Learning Time** | 78 hours (Face-to-face – 39 hours, Independent/group learning – 39 hours) |
| **13. Transferable Skills** | 1. Creative and critical thinking<br>2. Problem solving skill, planning and design skill |
| **14. Knowledge Required** | Familiarity with hydraulics, hydrology, and design of concrete structures. |

**15. Course Outcomes**

| | Course Learning Outcome (CO) | Corresponding Program Outcomes, PO(s) * | Domains and Taxonomy Level** Cognitive Domain (C) | Knowledge profile (K)*** | Complex problem solving (P)**** | Complex Engineering activities (A)***** | Delivery Method(s) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| 1 | Ability to *outline* the features and types of hydraulic structures. | PO-1 | C1 | - | P1 | - | Lectures, Tutorials, Homework | Assignment, Quiz, Final exam |
| 2 | Ability to *perform* hydrologic and hydraulic design of a hydraulic structure. | PO-2, PO-3, PO-4 | C3, C4, C5 | K2, K4 | P2 | - | Lectures, Tutorials, Homework | Assignment, Quiz, Final exam |
| 3 | Ability to *design* stilling basin and loose protection. | PO-2, PO-3, PO-4 | C3, C4, C5 | K2, K4 | - | - | Lectures, Tutorials, Homework | Assignment, Quiz, Final exam. |
| 4 | Ability to *perform* structural design: box conduit, wing wall, apron and retaining wall. | PO-2, PO-3, PO-4 | C3, C4, C5 | K2, K4 | - | - | Lectures, Tutorials, Homework | Assignment, Quiz, Final exam |

*__Programme Outcomes -PO (Outcomes of B.Sc. in Civil Engineering degree)__

PO-1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO-2: **Problem analysis:** Identify, formulate, research and analyse complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

PO-3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

PO-4: **Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

PO-5: **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

PO-6: **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO-7: **Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO-8: **Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

PO-9: **Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

PO-10: **Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO- 11: **Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

PO- 12: **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

**Cognitive Domain (C)**

---

***__The cognitive domain (C) and its Taxonomy Levels (1 to 6)__ aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

| | | |
|---|---|---|
| ***C1- knowledge/remember;*** | ***C2-understand/explain/estimate;*** | ***C3-apply;*** |
| ***C4-analysis;*** | ***C5-synthesis/design/create/construct;*** | ***C6-evaluate/judge/verify*** |

---

***Knowledge Profile (K)

| | |
|---|---|
| **K1** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| **K2** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| **K3** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| **K4** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| **K5** | *Knowledge that supports engineering design in a practice area* |
| **K6** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |
| **K7** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| **K8** | *Engagement with selected knowledge in the research literature of the discipline* |

****Complex Problem Solving (P)

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| **P1** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |
| **P2** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| **P3** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| **P4** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| **P5** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| **P6** | *Extent of stakeholder involvement and level of conflicting requirements* | *Involve diverse groups of stakeholders with widely varying needs* |
| **P7** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

*****Complex Engineering Activities (A)

| | ***Attribute*** | ***Complex Problems*** |
|---|---|---|
| **A1** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| **A2** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| **A3** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| **A4** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |

| | *Attribute* | *Complex Problems* |
|---|---|---|
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

## 16. Text Book/Reference Reading Materials:

1. "Irrigation Engineering and Hydraulic Structures", Author: Santosh Kumar Garg.

## 17. Lecture Schedule (3 Hours/ Week)

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Hydraulic Structures | Garg/Handout | CO1 |
| 02 | Hydrologic Design of a regulator: Generation of a hydrograph. | Garg/Handout | CO2 |
| 03 | Hydrologic Design of a regulator: Flood Routing by Goodrich Method. | Garg/Handout | |
| 04 | Hydraulic Design of a regulator: Determination of floor thickness (pre monsoon and post monsoon) | Garg/Handout | |
| 05 | Design of stilling basin parameters and loose protection. | Garg/Handout | CO3 |
| 06 | **MID TERM QUIZ** | - | - |
| 07 | Structural Design of box conduit | Handout | CO4 |
| 08 | Structural Design of wing wall | Handout | |
| 09 | Structural Design of apron | Handout | |
| 10 | Structural Design of retaining wall | Handout | |
| 11 | Structural Design review | Handout | |
| 12 | **FINAL QUIZ** | - | - |
| 13 | Course review | - | - |

## 18. Assessment Strategy

1. Class Attendance – Class participation and attendance will be recorded in every class
2. Daily Assessment– Daily Assessment may be in the form of laboratory performance, report writing and submission, short class test, VIVA etc.
3. Mid Quiz and Final Quiz – Two comprehensive written examinations which will be declared at least one week before occurrence.

## 19. Distribution of Marks

1. Class Participation: 10%,
2. Daily Assessment: 40%,
3. Quiz: 50%

## 20.77 Description of Course WRE 451

### Part-1: General Information

| | | |
|---|---|---|
| 1. | Course Number | WRE 451 |
| | Course Title | Hydrology, Irrigation and Flood Management |
| | Credit/Contact Hours | 3.00 |
| 2. | Level and Term | |
| | Academic Term | |
| 3. | Type of Course | Required Course |
| | Offered to | Civil Engineering Department |
| 4. | Pre-requisite Course(s) | None |
| 5. | Course Website (Section -B) | |
| 6. | Lecture Schedule (Online) | |
| 7. | Important Dates | For important dates and examination schedules and latest updates, please follow the course website. |
| 8. | Course Teachers | |

### Part-2: Course Details

| | | |
|---|---|---|
| 9. | **Course Content** (As approved by the Academic Council) | Hydrologic cycle; Weather and Hydrology; Precipitation, Evaporation and transpiration; Infiltration. Stream flow; Application of telemetry and remote sensing in hydrologic data acquisition; Rainfall-runoff relations; Hydrographs, unit hydrographs; Hydrologic routing; Statistical methods in hydrology; **Introduction and Overview of irrigation; Water Law of Bangladesh; Plant-soil-water relationship; Consumptive use and estimation of irrigation water requirements; Methods of irrigation; Quality of irrigation water; Problems of irrigated land; Flood and its management** <br> ***(Bold topics will be covered in Part-B)*** |
| 10. | **Course Objectives** | • To enable the student to understand the hydrologic process considering the complex interactions among precipitation, evaporation, transpiration and infiltration at any watershed scale. <br> • To be able to understand rainfall-runoff relationships, hydrographs and their analyses techniques. <br> • To be able to estimate irrigation requirements based on plant soil relationship, and consumptive use of crops. <br> • To understand the issues of irrigation field considering type of irrigation and quality of irrigation water. <br> • To be able to understand the floods and its managements in the context of Bangladesh. |

## 11. Knowledge Required

Fundamental understanding of Physics, Fluid Mechanics and Open Channel Flow.

## 12. Course Outcome

| | Course Learning Outcome (CO) | Corresponding Program Outcomes, PO(s) * | Domains and Taxonomy level(s)** Cognitive Domain (C) | Knowledge Profile (K)*** | Complex problem solving (P)**** | Complex Engineering activities (A)***** | Delivery Method(s) and Activity (ies) | Assessment Tool(s) |
|---|---|---|---|---|---|---|---|---|
| 1 | Ability to **explain** and **apply** fundamental concepts, techniques, and engineering knowledge used in hydrology, irrigation and food management | PO-1<br>PO-2 | C1, C4 | K1, K3 | P2, P3, P6 | A2, A3 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| 2 | **Explain** the physical processes involved in the hydrologic process and **analyse** the components of water budget for a catchment. | PO-1<br>PO-2<br>PO-3<br>PO-12 | C2, C4, C5, C6 | K3, K4, K5 | P2, P3 | A3 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| 3 | Ability to **develop** and **analyse** hydrographs for project design. | PO-2<br>PO-3<br>PO-12 | C4, C6 | K4, K5 | P3 | A3 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| 4 | Ability to **explain** the plant water relationship and **estimate** consumptive use for irrigation requirements. | PO-1<br>PO-2<br>PO-3<br>PO-12 | C2, C5, C6 | K1, K3 | P2, P3 | A2, A3 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |
| 5 | **Apply** engineering knowledge and social aspect for **determining** irrigation methods and flood managements. | PO-1<br>PO-2<br>PO-3 | C3, C4, C5 | K3, K5, K6 | P3, P6 | A2, A3 | Lectures, Tutorials, Home works | Assignment, Quiz, Final exam |

*Programme Outcomes -PO (Outcomes of B.Sc. in Water Resources Engineering degree)*

* PO-1: **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO-2: **Problem analysis:** Identify, formulate, research and analyze complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

PO-3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

PO-4: **Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

PO-5: **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

PO-6: **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO-7: **Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO-8: **Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

PO-9: **Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

PO-10: **Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO- 11: **Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a team member or a leader to manage projects in multidisciplinary environments.

PO- 12: **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

## Cognitive domain (C)

*****The cognitive domain (C) and its Taxonomy Levels (1 to 6)** aim to develop the mental skills and the acquisition of knowledge of the individual. The cognitive domain encompasses of six categories which include:*

***C1- knowledge/remember;*** ***C2-understand/explain/estimate;*** ***C3-apply;***

***C4-analysis;*** ***C5-synthesis/design/create/construct;*** ***C6-evaluate/judge/verify***

## ***Knowledge Profile (K)

| | |
|---|---|
| ***K1*** | *A systematic, theory-based understanding of the natural sciences applicable to the discipline* |
| ***K2*** | *Conceptually based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline* |
| ***K3*** | *A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline* |
| ***K4*** | *Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline* |
| ***K5*** | *Knowledge that supports engineering design in a practice area* |
| ***K6*** | *Knowledge of engineering practice (technology) in the practice areas in the engineering discipline* |

| | |
|---|---|
| ***K7*** | *Comprehension of the role of engineering in society and of the identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity in economic, social, cultural, environmental and sustainability terms* |
| ***K8*** | *Engagement with selected knowledge in the research literature of the discipline* |

### ****Complex Problem Solving (P)

| | *Attribute* | *Complex Problems* |
|---|---|---|
| ***P1*** | *Range of conflicting requirements* | *Involve wide-ranging or conflicting technical, engineering and other issues* |
| ***P2*** | *Depth of analysis required* | *Have no obvious solution and require abstract thinking and originality in analysis to formulate suitable models.* |
| ***P3*** | *Depth of knowledge required* | *Require research-based knowledge, much of which is at or informed by the forefront of the professional discipline, that allows a fundamental-based, first-principles analytical approach* |
| ***P4*** | *Familiarity of issues* | *Involve infrequently encountered issues* |
| ***P5*** | *Extent of applicable codes* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |
| ***P6*** | *Extent of stakeholder involvement and level of conflicting requirements* | *Involve diverse groups of stakeholders with widely varying needs* |
| ***P7*** | *Interdependence* | *Are high-level problems that include many component parts or sub-problems* |

### *****Complex Engineering Activities (A)

| | *Attribute* | *Complex Problems* |
|---|---|---|
| ***A1*** | *Range of resources* | *Involve the use of diverse resources (for this purpose, resources include people, money, equipment, materials, information and technologies)* |
| ***A2*** | *Level of interaction* | *Require the resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues* |
| ***A3*** | *Innovation* | *Involve the creative use of engineering principles and research-based knowledge in novel ways* |
| ***A4*** | *Consequences for society and the environment* | *Have significant consequences in a range of contexts, characterized by their difficulty of prediction and mitigation* |
| ***A5*** | *Familiarity* | *Are outside the problems encompassed by standards and codes of practice for professional engineering* |

**13. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**14. Distribution of Marks**

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

## 15. Text Book/Referenssce Reading Materials:

1. Irrigation Engineering & Hydraulic Structures: *S. K. Garg*
2. Fundamentals of Irrigation and On-farm Water Management Volume 1 &2, by M. H. Ali
3. Irrigation (Theory & Practice): *A. M. Micheal (2nd Edition)*
4. Irrigation Principles and Practices: *Vaughn E. Hansen & W. Israelsen*
5. Material Provided by the Instructor
6. Engineering Hydrology by Subramanya, K. Tata- McGraw Hill Publishing Company LTD
7. Applied Hydrology by V. T. Chow, David R. Maidment and Larry W. Mays. McGraw Hill Education

## 16. Lecture Schedule

**Section-A, 1.5 Cr. Hrs**

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction to Hydrology and Engineering Hydrology; Practical Applications of Hydrology | Handout; Subramanya Ch-1; Chow Ch-1 | CO-1 |
| 02 | Hydrologic Cycle; Residence Time | Handout; Chow Ch-1 | CO-1, CO-2 |
| 03 | Vapor Pressure and Saturation Vapor Pressure; Relative Humidity and Specific Humidity; Dew Point Temperature | Handout; Chow Ch-3 | CO-1, CO-2 |
| 04 | Formation of Precipitation; Forms of Precipitation | Handout; Subramanya Ch-2; Chow Ch-3 | CO-2 |
| 05 | Class Test 1 | | |
| 06 | Computation of Average Rainfall | Handout; Chow Ch-3 | CO-1, CO-3 |
| 07 | Evaporation and Transpiration | Handout; Chow Ch-3 | CO-2, CO-3 |
| 08 | Infiltration | Handout; Subramanya Ch-3; Chow Ch-3 | CO-2 |
| 09 | Stream Flow Measurements | Handout; Subramanya Ch-4 | CO-1, CO-3 |
| 10 | Application of Telemetry and Remote Sensing in Hydrologic Data Acquisition | Handout | CO-1, CO-3 |
| 11 | Definition of Runoff; Runoff Characteristics of Streams | Handout; Chow Ch-5 | CO-3 |
| 12 | Estimation of Yield; Rational Method | Handout; Subramanya Ch-7; Chow Ch-14 | CO-3 |
| 13 | Elements of Flood Hydrograph; Methods of Base Flow Separation; Effective Rainfall and Direct Runoff | Handout; Subramanya Ch-6 | CO-3 |
| 14 | Class Test 2 | | |
| 15 | Use of Unit Hydrograph for Simple and Complex Storm Events | Handout; Subramanya Ch-6 | CO-3 |
| 16 | Unit Hydrograph of Different Durations | Handout; Subramanya Ch-6 | CO-3 |
| 17 | Concept of Flood Routing; Hydrologic Channel Routing | Handout; Subramanya Ch-8; Chow Ch-8 | CO-1, CO-3 |
| 18 | Hydrologic Storage Routing | Handout; Subramanya Ch-8; Chow Ch-8 | CO-1 |
| 19 | Concept of Flood Frequency Studies; Gumbel Method | Handout; Subramanya Ch-7 | CO-1, CO-2, CO-3 |
| 20 | Numerical and Graphical Flood Frequency Analyses | Handout; Subramanya Ch-7 | CO-3 |

**Section-B, 1.5 Cr. Hrs**

| Lecture No | Topics | Suggested Reading | Corresponding CO(s) |
|---|---|---|---|
| 01 | Introduction and Overview, Water Law of Bangladesh | Handout | CO1 |
| 02 | Importance of irrigation | Handout, Garg Ch-1, Ali Ch-1,2 | CO1 |
| 03 | Plant-Soil-Water relationship | Handout, Garg Ch-2, Ali Ch-8 | CO4 |
| 04 | Plant-Soil-Water relationship | Handout, Garg Ch-2, Ali Ch-8 | CO4 |
| 05 | Plant-Soil-Water relationship | Handout, Garg Ch-2, Ali Ch-8 | CO4 |
| 06 | Class Test 1 | | - |
| 07 | Consumptive use & estimation of irrigation water requirements | Handout, Garg Ch-2, Ali Ch-8, 9 | CO1, CO4 |
| 08 | Consumptive use & estimation of irrigation water requirements | Handout, Garg Ch-2, Ali Ch-8,9 | CO1, CO4 |
| 09 | Consumptive use & estimation of irrigation water requirements | Handout, Garg Ch-2, Ali Ch-8,9 | CO1, CO4 |
| 10 | Methods of irrigation | Handout, Garg Ch-1, Ali Vol-2 Ch-2 | CO1, CO5 |
| 11 | Methods of irrigation | Handout, Garg Ch-1, Ali Vol-2 Ch-2 | CO1, CO5 |
| 12 | Methods of irrigation | Handout, Garg Ch-1, Ali Vol-2 Ch-2 | CO1, CO5 |
| 13 | Sources and quality of irrigation water | Handout, Garg Ch-1 | CO1, CO5 |
| 14 | Sources and quality of irrigation water | Handout, Garg Ch-1 | CO1, CO5 |
| 15 | Sources and quality of irrigation water | Handout, Garg Ch-1 | CO1, CO5 |
| 16 | Class Test 2 | | - |
| 17 | Problems of irrigation land | Handout, Ali Vol-2 Ch-7 | CO1, CO5 |
| 18 | Problems of irrigation land | Handout, Ali Vol-2 Ch-7 | CO1, CO5 |
| 19 | Problems of irrigation land | Handout, Ali Vol-2 Ch-7 | CO1, CO5 |
| 20 | Flood and its management | Handout | CO5 |
| 21 | Flood and its management | Handout | CO5 |

**Annex A: Definition of terms**

| Term | Definition |
|---|---|
| PEO | Program Educational Objectives |
| PO | Program Outcomes |
| CGPA | Cumulative Grade Point Average |
| CO | Course Outcome |
| CE | Civil Engineering |
| OBE | Outcome Based Education |
| COs | Course Outcomes |
| Ph.D | Doctor of Philosophy |
| OBA | Outcome-Based Accreditation |

## Annex B: List of program outcomes

The teaching methods in the department revolve around the program outcome set by the department. The department follows the following program outcomes for its undergraduate programs:

**PO1-Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**PO2-Problem analysis:** Identify, formulate, research and analyze complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences and the engineering sciences.

**PO3- Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal and environmental concerns.

**PO4- Investigation:** Conduct investigations of complex problems, considering experimental design, data analysis and interpretation and information synthesis to provide valid conclusions.

**PO5-Modern tool usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.

**PO6-The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

**PO7-Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

**PO8-Ethics:** Apply ethical principles and commit to the professional ethics, responsibilities and the norms of the engineering practice.

**PO9-Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

**PO10- Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

**PO11-Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one’s work as a team member or a leader to manage projects in multidisciplinary environments.

**PO12-Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

**Annex C: Domains and Taxonomy Levels**

| **Taxonomy** | **Level** |
|---|---|
| C | Cognitive |
| C1 | Knowledge |
| C2 | Comprehension |
| C3 | Application |
| C4 | Analysis |
| C5 | Synthesis |
| C6 | Evaluation |
| A | Affective |
| A1 | Receiving |
| A2 | Responding |
| A3 | Valuing |
| A4 | Organizing |
| A5 | Characterizing |
| P | Psychomotor |
| P1 | Perception |
| P2 | Set |
| P3 | Guided Response |
| P4 | Mechanism |
| P5 | Complex Overt Response |
| P6 | Adaptation |
| P7 | Organization |

## Annex D: Format of the Course Outline

## 1.1 Description of Course ABC 111

**Section A: General Information**

| | |
|---|---|
| 1.1.1 Course Title | Insert your course title here |
| 1.1.2 Type of Course | Insert course type (Core/Optional/Session/Non-departmental) |
| 1.1.3 Offered to | Insert the name of the Department |
| 1.1.4 Pre-requisite Course(s) | Insert course numbers if applicable |

### Section B: Course Details

1.1.5 Course Content (As approved by the Academic Council)

Insert course content here

1.1.6 Course Objectives

- Objective 1
- Objective 2

1.1.7 Knowledge required

Insert previous knowledge requirements

1.1.8 Course Outcomes

| CO No. | CO Statement | Corresponding PO(s)* | Domains and Taxonomy level(s)** | Delivery Method(s) and Activity(-ies) | Assessment Tool(s) |
|---|---|---|---|---|---|
| 1 | CO1 statement | e.g., PO(a) | e.g., C2 | e.g., Lectures, Homework | e.g.,Written exams; viva voce; presentation; assignment |
| 2 | CO2 statement | | | | |
| 3 | CO3 statement | | | | |
| 4 | CO4 statement | | | | |
| 5 | CO5 statement | | | | |

1.1.9 Lecture Plan

| Class No. | Topics | References | Corresponding CO(s) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| … | | | |
| … | | | |
| 42 | | | |

1.1.10 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

1.1.11 Distribution of Marks

| | |
|---|---|
| Class Participation | 10% |
| Continuous Assessment | 20% |
| Final Examination | 70% |
| Total | 100% |

1.1.12 Textbook/References

1. Reference 1
2. Reference 2