SCHOOL OF CIVIL ENGINEERING

# GALGOTIAS UNIVERSITY

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# COURSE BOOK

## SCHOOL OF CIVIL ENGINEERING -2019

## Volume-I

**Curriculum and syllabus for**

**School of Civil Engineering**

GALGOTIAS UNIVERSITY

(Under the Uttar Pradesh Private Universities Act No. 12 of 2019)

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GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

# Program: B. Tech in Civil Engineering

**Scheme: 2020-2021**

**Vision**

To be a Centre of Excellence for imparting high end research and technical education in Civil Engineering producing socially aware professionals to provide sustainable solutions to global community.

**Mission**

**M1:** To impart quality education and mould technically sound, ethically responsible professionals in the field of Civil Engineering.

**M2:** Collaborate with industry and society to design a curriculum based on the changing needs of stakeholders and provide excellence in delivery and assessment.

**M3:** Establish state-of-the-art facilities for world class education and research.

**M4:** To mentor students in pursuit of higher education, entrepreneurship and global professionalism.

**PEOs**

**PEO1:** Graduates shall attain state of the art knowledge in the different streams of Civil Engineering and be trained for playing the role of competent Civil Engineer in multidisciplinary projects.

**PEO2:** Graduates shall be capable of pursuing productive careers in private and government organizations at the national and international level and to become successful entrepreneurs.

**PEO3:** Graduates shall display a high sense of social responsibility and ethical thinking and develop sustainable engineering solutions.

**PSOs**

**PSO1:** Develop the ability to implement emerging techniques to plan, analyze, design, execute, manage, maintain and rehabilitate systems and processes in diverse area like structural, environmental, geotechnical, transportation and water resources engineering.

**PSO2:** Excel in research, innovation, design, problem solving using different softwares and artificial intelligence and develop an ability to interact and work seamlessly in multidisciplinary environment.

**POs**

**PO1:** Apply the knowledge of Mathematics, Science, and Engineering fundamentals, and an engineering specialization to solution of complex engineering problems (Engineering Knowledge)

**PO2:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (Problem analysis)

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

**PO4:** Use research based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions (Conduct investigations of complex problems)

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

**PO6:** Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice (The engineer and society)

**PO7:** Understand the impact of the professional engineering solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments (Environment and sustainability)

**PO8:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (Ethics)

**PO9:** Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings (Individual and team work)

**PO10:** Communicate effectively on complex engineering activities with the engineering community and with society at large such as being able to comprehend and write effective reports and design documentation, make effective oral presentations, and give and receive clear instructions (Communication)

**PO11:** Demonstrate knowledge and understanding of engineering management principles and apply those to one's own work as a member and leader of a team to manage projects in multidisciplinary environments (Project management and finance)

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

**Curriculum**

| Semester 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | BMA101 | Mathematics-I (Multivariable Calculus) | 3 | 1 | 0 | 3 | 20 | 30 | 50 |
| 2 | BPH101 | Engineering Physics | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | FENG1005 | Functional English | 2 | 0 | 0 | 2 | 20 | 30 | 50 |
| 4 | BCS101 | Fundamentals of Computer Programming | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BME101 | Elements of Mechanical Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | BMA151 | Exploration with CAS - I | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 7 | BPH151 | Engineering Physics Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 8 | BCS151 | Fundamentals of Computer Programming Lab - I | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 9 | BME151 | Workshop Practice | 0 | 0 | 2 | 1 | 50 | - | 50 |
| | | **Total** | | | | **18** | | | |
| **Semester II** | | | | | | | | | |
| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | BMA201 | Linear Algebra and Differential Equations | 3 | 2 | 0 | 3 | 20 | 30 | 50 |
| 2 | BCH101/ BCH102 | Engineering Chemistry/Engineering Sciences | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | BLE101 | Psychology and Sociology | 2 | 0 | 0 | 2 | 20 | 30 | 50 |
| 4 | BEC101 | Basic Electrical and Electronics Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BMA251 | Exploration with CAS - II | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 6 | BCH152 / BCH153 | Engineering Chemistry Lab/Engineering Sciences Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 7 | BHS251 | Professional Communication Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 8 | BCS251 | Application of Programming using Python | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 9 | BEC151 | Basic Electrical and Electronics Engineering Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 10 | BME152 | Engineering Graphics | 0 | 0 | 4 | 2 | 50 | - | 50 |
| 11 | BOC253 | Design and Innovation | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 12 | BCS901 | Disruptive Technologies | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| | | **Total** | | | | **22** | | | |
| **Semester III** | | | | | | | | | |
| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | MATH2008 | Functions of Complex Variables and Transforms | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | BTME2001 | Engineering Mechanics | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | BTCE2001 | Fluid Mechanics | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | BTCE2002 | Surveying | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BTCE2003 | Construction Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | BTCE2004 | Fluid Mechanics Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 7 | BTCE2005 | Surveying Practices | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 8 | BTCE2006 | Construction Engineering Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 9 | BTCE2007 | PBL-1 | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 10 | SLBT2021 | English Proficiency and Aptitude Building - 2 (Soft Skill - 3) | 0 | 0 | 4 | 2 | 50 | - | 50 |
| | | **Total** | | | | **21** | | | |

**Semester IV**

| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | BTCE2015 | Highway Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | BTCE2008 | Mechanics of Materials | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | BTCE2009 | Hydrology & Hydraulic Systems | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | BTCE2010 | Water Supply & Treatment Systems | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BTCE3003 | Geotechnical Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | BTCE2011 | Mechanics of Materials Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 7 | BTCE2012 | Water Quality Analysis Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 8 | BTCE3006 | Geotechnical Engineering Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 9 | BTCE2014 | PBL-2 (Project Management) | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 10 | SLBT2022 | English Proficiency and Aptitude Building - 3 | 0 | 0 | 4 | 2 | 50 | - | 50 |
| | | **Total** | | | | **21** | | | |

**Semester V**

| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | MATH3010 | Numerical Methods | 2 | 0 | 0 | 2 | 20 | 30 | 50 |
| 2 | BTCE3001 | Structural Analysis | 3 | 0 | 0 | 3 | 50 | - | 50 |
| 3 | BTCE3002 | Design of Reinforced Concrete Structures | 3 | 0 | 0 | 3 | 50 | - | 50 |
| 4 | BTCE3010 | Transportation Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BTCE3004 | Waste Water Treatment & Disposal | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | MATH252 | Numerical Methods Lab | 0 | 0 | 2 | 1 | 20 | 30 | 50 |
| 7 | BTCE3005 | Structural Analysis Lab | 0 | 0 | 2 | 1 | 20 | 30 | 50 |
| 8 | BTCE3045 | Remote Sensing & Geographical Information System | 2 | 0 | 2 | 3 | 20 | 30 | 50 |
| 9 | BTCE3011 | Transportation Engineering Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 10 | BTCE3007 | PBL-3 | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 11 | SLBT3001 | English Proficiency and Aptitude Building - 4 (Soft Skill-5) | 0 | 0 | 4 | 2 | 50 | - | 50 |
| 12 | BTCE3041 | Industrial Internship - I | 0 | 0 | 0 | 1 | 50 | - | 50 |
| 13 | BTCE3008 | CAD LAB - I (AUTOCAD) (Skill Course- 1) | 0 | 0 | 4 | 2 | 50 | - | 50 |
| | | **Total** | | | | **26** | | | |

| Semester VI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sl No | Course Code | Name of the Course | | | | | Assessment Pattern | | |
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | BTMG3002 | Organizational Behavior | 3 | 0 | 0 | 3 | 50 | - | 50 |
| 2 | BTCE3009 | Design of Steel Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | SLBT3002 | Campus to Corporate (Soft Skill - 6) | 0 | 0 | 4 | 2 | 50 | - | 50 |
| 4 | BTCE3040 | PBL-4 (PRIMAVERA) | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 5 | BTCE3013 | CAD Lab - II (STAAD PRO) (Skill Course- 1) | 0 | 0 | 4 | 2 | 50 | - | 50 |
| 6 | BTCE3014 | Advanced Structural Analysis | 3 | 0 | 0 | 3 | 50 | - | 50 |
| 7 | | Program Elective (from basket) - 1 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 8 | | Program Elective (from basket) - 2 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 9 | | Open Elective - I | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 10 | BTCE3042 | Design and Innovation | 0 | 0 | 2 | 1 | 20 | 30 | 50 |
| | | **Total** | | | | **24** | | | |
| **Semester VII** | | | | | | | | | |
| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | | Management Course (From Basket) | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | | Program Elective (from basket) - 3 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | | Program Elective (from basket) - 4 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | | Program Elective (from basket) - 5 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BTCE4002 | Industrial Internship - II | 0 | 0 | 0 | 1 | 50 | - | 50 |
| 6 | BTCE9998 | Project Work -1 | 0 | 0 | 6 | 3 | 50 | - | 50 |
| 7 | | Open Elective - II | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| | | **Total** | | | | **19** | | | |
| **Semester VIII** | | | | | | | | | |
| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | | | | **L** | **T** |
| 1 | BTCE9999 | Project Work -2 | 0 | 0 | 18 | 9 | 50 | - | 50 |
| | | **Total** | | | | **9** | | | |

## List of Program Electives

| Sl No | Course Code | Name of the Electives | | | | | Assessment Pattern | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | BTCE3015 | Advanced Concrete Design | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | BTCE3016 | Quantity Surveying & Estimating | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | BTCE3017 | Bridge Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | BTCE3018 | Applications of Matrix Methods in Structural Analysis | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BTCE3019 | Expansive Soil and Ground Improvement Techniques | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | BTCE3020 | Advanced Geotechnical Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 7 | BTCE3021 | Highway Pavement Design | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8 | BTCE3022 | Traffic Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 9 | BTCE3024 | Ground Water Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 10 | BTCE3025 | Advanced Hydrology | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 11 | BTCE3026 | Pollution Control and Monitoring | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 12 | BTCE3027 | Industrial Waste Treatment and Disposal | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 13 | BTCE3028 | Air and Noise Pollution | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

**List of Minor Courses**

| Sl No | Course Code | Name of the Electives | | | | | Assessment Pattern | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | BTCE2002 | Surveying | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | BTCE2003 | Construction Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | BTCE2008 | Mechanics of Materials | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | BTCE2010 | Water Supply & Treatment System | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BTCE3010 | Transportation Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

**List of Major Courses**

| Sl No | Course Code | Name of the Electives | | | | | Assessment Pattern | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | BTCE4007 | Pre Stressed Concrete Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | BTCE4008 | Dynamics of Structures and Earthquake Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | BTCE4009 | Open Channel Hydraulics | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | BTCE4010 | Water Resources Systems Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | BTCE4011 | Transport Planning and Management | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Fluid Mechanics** | | | | |
| **Course Code** | **BTCE2001** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 3 | 0 | 0 | 3 | |

**Course Objectives**

1. To enable the students to understand fluid properties.
2. To enable the students to explain different types of flows.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand fluid properties. |
| **CO2** | Determine momentum and energy correction factors. |
| **CO3** | Explain open channel flow. |
| **CO4** | Apply Buckingham π theorem. |
| **CO5** | Distinguish between laminar flow and turbulent flow. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Fluid Properties and Hydrostatics**<br><br>**8 lecture hours** |
| Density – Viscosity – Surface tension – compressibility – capillarity – Hydrostatic forces on plane – inclined and curved surfaces – buoyancy – centre of buoyancy – metacentre. |
| **Unit II: Fluid Dynamics**<br><br>**9 lecture hours** |
| Control volume – Fluid Kinematics - Types of flows; Steady flow, Unsteady flow, Uniform and Non Uniform flow, Rotational flow, Irrotational flow, 1-D, 2-D, 3-D flows– Streamline and Velocity potential lines- Euler and Bernoulli's equations and their applications – moment of momentum – Momentum and Energy correction factors – Impulse – Momentum equation - Navier-Stokes Equations-Applications |
| **Unit III: Open Channel Flow**<br><br>**9 lecture hours** |
| Flow through pipes – Open Channels and Measurement pipe flow: Darcy's law – Minor losses – Multi reservoir problems – pipe network design – Moody's diagram – Hagen Poiseuille equation – Turbulent flow. Specific Energy – Critical flow concept – specific force – Hydraulic jump – uniform flow and gradually varying flow concepts. – Measurement of pressure – flow – velocity through pipes and open channels. |
| **Unit IV: Dimensional Analysis**<br><br>**6 lecture hours** |
| Dimensional homogeneity – Raleigh and Buckingham π theorems – Non-dimensional numbers – Model laws and distorted models - Module quantities - Specific quantities. |
| **Unit V: Boundary layers**<br><br>**8 lecture hours** |
| Boundary layers – Laminar flow and Turbulent flow – Boundary layer thickness – momentum – Integral equation – Drag and lift-Separation of boundary layer-Methods of separation of boundary layer. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. R. K. Bansal (2010), A Textbook of Fluid Mechanics and Hydraulic Machines 9th Ed. Laxmi Publication, ISBN- 9788131808153.

2. P. N. Modi and S. M. Seth (2011), Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Publications. ISBN- 9788189401269.

3. V.L. Streeter, (2001), Fluid Mechanics, McGraw Hill Book Co. ISBN – 9780071156004.

| Name of The Course | Surveying | | | |
|---|---|---|---|---|
| Course Code | BTCE2002 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To enable the students to understand the basics of surveying and different techniques of surveying.
2. To help the students to learn the field applicability of the different survey methods.
3. To make the students learn different types of errors encountered in different types of surveying.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Learn about basics involved in different types of surveying like tape, compass, leveling, and theodolite (total station). |
| **CO2** | Demonstrate skills in performing measurement of distance, angles, leveling, and curve setting. |
| **CO3** | Develop skills for estimating distance between given points, area of a given plot and earthwork involved in cuttings and fillings. |
| **CO4** | Develop skill to carry out tachometry, geodetic surveying wherever situation demands. |
| **CO5** | Develop skills to apply error adjustment to the recorded reading to get an accurate surveying output. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Plane Surveying and Theodolite**<br>**9 lecture hours** |
| Introduction to plane surveying, conventional tape measurement, electronic distance measurement – Meridians, Azimuths and bearings – Theodolites – Temporary and permanent adjustment – Horizontal and Vertical angle measurements – Electronic total station. |
| **Unit II: Leveling and Contouring**<br>**8 lecture hours** |
| Differential leveling, Longitudinal & cross section leveling, Refraction & curvature correction, Reciprocal leveling -Tachometry – Stadia tachometry, tangential tachometry & substance tachometry- Contouring. |
| **Unit III: Calculation of Earthwork and GPS**<br>**8 lecture hours** |
| Area, volume calculation of earth work – Introduction to Global positioning system – GPS surveying methods. |
| **Unit IV: Curve Surveying**<br>**6 lecture hours** |
| Definitions, designation of curve, elements of simple curve - Settings of simple circular curve, Compound and reverse curve- Transition curve – Introduction to vertical curves. |
| **Unit V: Geodetic surveying**<br>**9 lecture hours** |
| Introduction to geodetic surveying, Triangulation surveying – Base line measurement & correction, Satellite station. Surveying adjustments – Principle of least square and adjustment of triangulation network. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Punmia B.C. (2005), Surveying, Volume 1, 16th Edition Laxmi Publications. ISBN: 9788170080794
2. Punmia B.C. (2005), Surveying, Volume 2, 15th Edition Laxmi Publications. ISBN: 9788170080800
3. Kanetkar T.P. (2006), Surveying and Levelling, Vol I, Pune. ISBN: 9788185825113.

4. Kanetkar T.P. (2008), Surveying and Levelling, Vol II, Pune. ISBN: 9788185825007

| Name of The Course | Mechanics of Materials | | | |
|---|---|---|---|---|
| Course Code | BTCE2008 | | | |
| Prerequisite | BTME2001 | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To know the concept of stresses and strains.
2. To know the concept of shear force and bending moment.
3. To calculate deflection in beams and trusses.
4. To determine the buckling and crushing load of compression members.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the concepts of volumetric strain, principle stresses and torsion. |
| **CO2** | Analyse shear force and bending moment for different types of beams. |
| **CO3** | Calculate deflections in beams. |
| **CO4** | Determine deflections in plane trusses. |
| **CO5** | Distinguish between short column and long column. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: Volumetric Strain, Principle Stresses and Torsion**<br><br>**10 lecture hours** |
|---|
| Bulk Modulus – Modulus of rigidity – Change in volume – Volumetric Strain - Principle stresses - Mohr's circle – Introduction to torsion - Torsion of shafts of circular section - torque and twist - shear stress due to torque. |
| **Unit II: Shear Force and Bending Moment** **8 lecture hours** |
| Types of beams, supports and loadings - shear force and bending moment diagram - bending stresses and shear stresses in beams. |
| **Unit III: Deflection of Beams** **8 lecture hours** |
| Introduction - Theory of bending - deflection of beams by Macaulay's method - moment area method and conjugate beam method. |
| **Unit IV: Strain Energy**<br><br>**7 lecture hours** |
| Strain Energy - Castigliano's theorem - calculation of deflection in statically determinate beams and plane trusses - Unit load methods - Williot Mohr's diagram. |
| **Unit V: Theory of Columns**<br><br>**7 lecture hours** |
| Theory of Columns - long column and short column - Euler's formula - Rankine's formula - Secant formula - beam column. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Gere J. M. and Thimoshenko S. P. (2008), Mechanics of Materials, 8th Edition, CBS Publishers & Distributors, ISBN: 9780534417932.
2. Popov E. P. (2009), Engineering Mechanics of Solids, 2nd Edition, Prentice Hall Publisher, ISBN: 9788120321076.
3. Bansal R. K. (2010), Strength of Materials, 4th Edition, Laxmi Publications, ISBN: 9788131808146.

| Name of The Course | Mechanics of Materials Lab |
|---|---|

| Course Code | BTCE2011 | | | |
|---|---|---|---|---|
| Prerequisite | BTCE2008 | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To supplement the theoretical knowledge gained in Mechanics of Materials with practical testing for determining the strength of materials under externally applied loads.
2. This would enable the student to have a clear understanding of the design for strength and stiffness.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Conduct tension and compression tests on the components. |
| **CO2** | To determine hardness, impact strength, fatigue strength of the specimens. |
| **CO3** | Measure strain and load using specific gauges. |
| **CO4** | Measure torsion in mild steel. |
| **CO5** | Compression and tension test on helical springs. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. Tension test on a mild steel rod, thin and twisted bars.
2. Compression test on Bricks, Concrete blocks.
3. Double shear test on Mild steel and aluminium rods.
4. Impact test on metal specimen (Charpy test and Izod test).
5. Hardness test on metals (Steel, Copper and Aluminium) - Brinell Hardness Number.
6. Hardness test on metals (Steel, Copper and Aluminium) - Rockwell Hardness Number.
7. Deflection test – Verification of Maxwell theorem.
8. Compression and tension test on helical springs.
9. Fatigue test on Steel.
10. Torsion test on mild steel

**Suggested Reading**

1. Gere J. M. and Thimoshenko S. P. (2008), Mechanics of Materials, 8th Edition, CBS Publishers & Distributors, ISBN: 9780534417932.
2. Popov E. P. (2009), Engineering Mechanics of Solids, 2nd Edition, Prentice Hall Publisher, ISBN: 9788120321076.
3. Bansal R. K. (2010), Strength of Materials, 4th Edition, Laxmi Publications, ISBN: 9788131808146.

| Name of The Course | Fluid Mechanics Lab | | | |
|---|---|---|---|---|
| Course Code | BTCE2004 | | | |
| Prerequisite | BTCE2001 | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. Introduce concepts, laws, observations, models of fluids at rest and in motion and understanding fluid behavior for engineering design and control of fluid system.
2. Develop competence with mass, energy and momentum balances for determining resultant interactions of flows and engineered and natural systems.
3. The development of boundary layers and advancement of practical hydraulics and understanding the concept of advanced fluid mechanics.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | To find frictional losses in a pipe when there is a flow between two places. |
| **CO2** | Calculation of conjugate depth in a flow and to analyse the model and prototype. |
| **CO3** | Find the dependent and independent parameters for a model of fluid flow. |

| | |
|---|---|
| **CO4** | Explain the various methods available for the boundary layer separation |
| **CO5** | Calculate losses in pipe. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

1. Verification of Bernoullis Theorem
2. Metacentric Height
3. Calibration of V- Notch
4. Calibration of Rectangular Notch
5. Calibration of Trapezoidal Notch
6. Calibration of Venturimeter
7. Calibration of Orificemeter
8. Losses in Pipes

**Suggested Reading**

1. R. K. Bansal (2010), A Textbook of Fluid Mechanics and Hydraulic Machines 9th Ed. Laxmi Publication, ISBN- 9788131808153.

2. P. N. Modi and S. M. Seth (2011), Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Publications. ISBN- 9788189401269.

3. D.S. Kumar (2004), Fluid Mechanics and Fluid Power Engineering, Katson Publishing House, ISBN - 9788185749181.

4. V.L. Streeter, (2001), Fluid Mechanics, McGraw Hill Book Co. ISBN – 9780071156004.

| **Name of The Course** | **Surveying Practices** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE2005** | | | |
| **Prerequisite** | BTCE2002 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To teach the students basics of surveying and expose different techniques of surveying.
2. To help the students to learn the field applicability of the different survey methods.
3. To teach students about types of errors encountered in different types of surveying.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Learn about basics involved in different types of surveying like tape, compass, leveling, and theodolite (total station). |
| **CO2** | Demonstrate skills in performing measurement of distance, angles, leveling, and curve setting. |
| **CO3** | Develop skills for estimating distance between given points, area of a given plot and earthwork involved in cuttings and fillings. |
| **CO4** | Develop skill to carry out tachometry, geodetic surveying wherever situation demands. |
| **CO5** | Develop skills to apply error adjustment to the recorded reading to get an accurate surveying output. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. Chain Survey- Determination of area by perpendicular offsets
2. Chain Survey- Measurement of distance by chaining & ranging
3. Compass Survey- Plotting & adjustment of closed traverse
4. Theodolite Survey- Measurement of horizontal angles by method of repetition
5. Measurement of Vertical Angles and Determination of Height of an Object
6. Plane Table Survey- Radiation method
7. Levelling- Rise & Fall method
8. Levelling- Height of collimation method
9. Trignometrical Levelling- Single plane method

10. Curve Surveying- Setting out a simple circular curve by Rankine's method
11. Contouring- To determine the contours for a given location
12. GPS Survey- Coordinates & Distance measurement using GPS
13. Total Station- Measurement of Altitude of Given Elevated Points
14. Total Station- Measurement of distance & coordinates of given points
15. Stereoscope- Use of stereoscope for 3D viewing
16. Stereoscope- Determination of height of objects from a stereo pair using the parallax bar

**Suggested Reading**

1. Punmia B.C. (2005), Surveying, Volume 1, 16th Edition Laxmi Publications. ISBN: 9788170080794
2. Punmia B.C. (2005), Surveying, Volume 2, 15th Edition Laxmi Publications. ISBN: 9788170080800
3. Kanetkar T.P. (2006), Surveying and Levelling, Vol I, Pune. ISBN: 9788185825113.
4. Kanetkar T.P. (2008), Surveying and Levelling, Vol II, Pune. ISBN: 9788185825007

| **Name of The Course** | **PBL-1** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE2007** | | | |
| **Prerequisite** | BTCE2002, BTCE2003 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems pertaining to civil engineering domain.
2. To foster collaborative learning skills.
3. To develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Identify, formulate, and solve engineering problems. |
| **CO2** | Understand planning and scheduling of a project. |
| **CO3** | Submit a project report comprising of the application and feasibility of the project. |
| **CO4** | Work and communicate efficiently in multidisciplinary teams. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| **Components** | **Internal Evaluation** | | **Final Evaluation** | |
|---|---|---|---|---|
| | **Online Examination and Viva voice - I** | **Online Examination and Viva voice - II** | **Project Report** | **Online Examination and Viva voice (ETE)** |
| **Marks** | **25** | **25** | **20** | **30** |
| **Total Marks** | **100** | | | |

**List of Projects:**

1. Comparative study of chain survey, compass survey and theodolite survey.
2. Studies on GPS survey.
3. Surveying B – block in GU campus by Total Station.
4. Studies on high performance concrete.
5. Studies on self compacting concrete.
6. Studies on structural light weight concrete.
7. Mix Design for preparing M40 grade of concrete.

**Suggested Reading**

1. Punmia B.C. (2005), Surveying, Volume 1, 16th Edition Laxmi Publications. ISBN: 9788170080794.

2. Punmia B.C. (2005), Surveying, Volume 2, 15th Edition Laxmi Publications. ISBN: 9788170080800.
3. Rangwala, (2011), *Engineering Materials*, 38th edition, Charotar Publishing House Pvt. Ltd. ISBN: 978-93-80358-26-0.
4. Ashok Kumar Jain, Dr. B.C. Punmia, Arun Kumar Jain (2009), Building Construction, Laxmi Publications Pvt. Ltd, ISBN: 978-81-318-0428-5.

| **Name of The Course** | **Structural Analysis** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BTCE3001** | | | | |
| **Prerequisite** | BTCE2008 | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 3 | 0 | 0 | 3 | |

**Course Objectives**

1. To understand the concept of static indeterminacy.
2. To know the different techniques available for the analysis of statically indeterminate structures.
3. To identify the best suitable method of analysis.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Identify the method of analysis for statically indeterminate structures. |
| **CO2** | Understand the difference between statically determinate structures and statically indeterminate structures. |
| **CO3** | Use the influence line diagram for analysing beam. |
| **CO4** | Understand strain energy method to analyse arches. |
| **CO5** | Analyse beams and portals by slope deflection method. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: Theorem of Three Moments**<br><br>**8 lecture hours** |
|---|
| Static indeterminacy - Theorem of three moments - analysis of propped cantilevers - fixed & continuous beam - bending moment and shear force diagram. |
| **Unit II: Strain Energy Method**<br><br>**8 lecture hours** |
| Static indeterminacy - Strain energy method - analysis of indeterminate structures, beams, pin jointed and rigid jointed structures - temperature effect - bending moment and shear force diagram. |
| **Unit III: Influence Line**<br><br>**8 lecture hours** |
| Influence line - influence lines for bending moment and shear force for beams, Muller Breaslau's principle - Maxwell's reciprocal theorem - Maxwell Betti's theorem. |
| **Unit IV: Analysis of Arches**<br><br>**8 lecture hours** |
| Two hinged and three hinged parabolic arches - circular arches - cables - tension forces in towers - influence line for horizontal thrust and bending moment. |
| **Unit V: Slope deflection method**<br><br>**8 lecture hours** |
| Kinematic indeterminacy - Slope deflection method - analysis of continuous beams and portals - bending moment and shear force diagram. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Vazirani & Ratwani (2003), Analysis of Structures, Vol. 1 & II, Khanna Publishers, ISBN: 0125249853.
2. S. Ramamrutham (2004), Theory of Structures, 5thEdition, Dhanpat Rai Publications, ISBN: 978041528091
3. C. S. Reddy (2010), Structural Analysis, 3rd Edition, Tata McGraw Hill, ISBN:9780070702769.
4. Kenneth M. Leet, Gilbert A, Uang C. M. (2010), Fundamentals of Structural Analysis, 4th Edition, Tata McGraw Hill,ISBN:9780071289382.

| **Name of The Course** | **Construction Engineering** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE2003** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To know different types of modern construction materials and their uses.
2. To know different types of cement, mineral and chemical admixtures, aggregates and their Engineering properties and uses.
3. To understand the properties and application of various special concretes.
4. To know the methodology of mix design and their application in accordance with various field conditions.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Develop ability to choose the modern construction materials appropriate to the climate and functional aspects of the buildings. |
| **CO2** | Supervise the construction technique to be followed in brick and stone masonry, concreting, flooring, roofing and plastering etc. |
| **CO3** | Understand the properties of cement and its laboratory testing methods. |
| **CO4** | Determine quality of fine aggregate and course aggregate. |
| **CO5** | Learn about the different properties of concrete. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: Properties of Construction Materials**<br><br>**8 lecture hours** |
|---|
| Physical and Mechanical properties of construction materials – Bricks - Stones - Structural Steel and Aluminum – Roofing Material – Physical descriptions of asbestos sheets, GI sheets, tubes and light weight roofing materials - Timber and its Products – Modern materials – Neoprene - Thermo Cole - Vinyl flooring - decorative panels and laminates - anodized aluminum - architectural glass and ceramics - Ferro cement – PVC - Polymer base materials and FRP. |
| **Unit II: Construction Technology**<br><br>**8 lecture hours** |
| Introduction to Masonry design, Principles of construction– Bonding – Reinforced brick work – – Stone masonry – Hollow block masonry - Pointing - Plastering – DPC Floor and Roof Construction: Floors, General Principles – Types of floors – Floor coverings – Types of roofs. |
| **Unit III: Calculation of Earthwork and GPS**<br><br>**8 lecture hours** |
| ASTM classification of Cement – Properties of Cement - Testing of Cement – Field Testing – Laboratory Testing methods – Setting time of cement – soundness of cement – fineness and compressive strength of cement - Heat of Hydration. |
| **Unit IV: Fine Aggregate and Coarse Aggregate**<br><br>**8 lecture hours** |

| |
|---|
| Fine aggregate – Properties and testing methods – Bulking of Sand – sieve analysis – fineness modulus of sand - Cement mortar – properties and uses, Chemical Admixtures- Plasticizer – super plasticizer – air entraining agents etc. |
| **Unit V: Properties of Concrete**<br><br>**8 lecture hours** |
| Concrete – selection of materials for concrete - water cement ratio - Properties of fresh concrete - workability – measurement of workability – Strength of concrete – gain of strength with age – testing of hardened concrete - Compressive strength - Tensile strength – Flexural strength – modulus of elasticity of concrete – Introduction to Mix Design of concrete. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Shetty, M.S. (2010), Concrete Technology, S. Chand & Company Ltd. ISBN- 9788121900034.
2. Neville. A.M. (2010) Specification of Properties of Concrete, Standard Publishers Distributors. ISBN- 9780273755807
3. Gambhir, M. L. (2012), Concrete Technology, McGraw- Hill. ISBN- 9780070151369.
4. 4. IS: 10262-2009, Guidelines for concrete mix design proportioning, BIS, New Delhi.

| **Name of The Course** | **Geotechnical Engineering** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BTCE3003** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | | **L** | **T** | **P** | **C** |
| | | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To impart the fundamental concepts of soil mechanics.
2. To understand the bearing capacity.
3. To know the importance of index properties like grain size, consistency limits, soil classification.
4. To understand the concept of compaction and consolidation of soils.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Give an engineering classification of a given soil. |
| **CO2** | Understand the principle of effective stress, and then calculate stresses that influence soil behavior. |
| **CO3** | Determine soil deformation parameters, and calculate settlement magnitude and rate of settlement. |
| **CO4** | Specify soil compaction requirements. |
| **CO5** | Conduct laboratory tests, and obtain soil properties and parameters from the test observations and results. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Weight volume relations and Index properties**<br>**12 lecture hours** |
| Distribution of soil in India, Soil - Types, 3-phase diagram, Weight-volume relations, Classification, Index properties (Atterberg's limits), Theory of compaction, Importance of geotechnical engineering. |
| **Unit II: Soil water and Permeability**<br><br>**8 lecture hours** |
| Soil water - Effective and neutral stresses – Flow of water through soils – Permeability – Darcy's law –Seepage and flow-nets - Quick sand conditions. |
| **Unit III: Stress distribution in soils**<br><br>**8 lecture hours** |

| |
|---|
| Vertical pressure distribution- Boussinesq's equation for point load and uniformly distributed loads of different shapes– Newmark's influence chart – Westergaard's equation – Isobar diagram – Pressure bulb - Contact pressure, Earth Pressures Theories. |
| **Unit IV: Compressibility and Consolidation**<br><br>**8 lecture hours** |
| Compressibility – e-log p curve – Pre-consolidation pressure - Primary consolidation – Terzaghi'sconsolidation theory - Laboratory consolidation test – Determination of $C_v$ by Taylor's and Casagrande's methods. |
| **Unit V: Shear strength of soils**<br><br>**9 lecture hours** |
| Stress analysis by Mohr's circle - Mohr's strength theory – Shear strength of soils – Mohr-Coloumb strength envelope – Laboratory shear tests – Direct shear test – Triaxial compression – Unconfined compression test – Vane shear test – Shear strength of saturated cohesive soils – Shear strength of cohesion less soils - conditions for liquefaction. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. K. R. Arora (2011), Soil Mechanics and Foundation Engineering, Standard Publishers Distributors, Delhi, ISBN: 978-81-801-4112-6.

2. Arun Kr. Jain, B.C. Punmia, Ashok Kr. Jain (2005), Soil Mechanics and Foundations, Sixteenth Edition, Laxmi Publications. ISBN: 978-81-700-8791-5.

3. Gopal Ranjan, A.S.R Rao (2000), Basic and Applied Soil Mechanics 2nd Edition, New Age International. ISBN: 978-81-224-1223-9.

4. William Powrie, Soil Mechanics: Concepts and Applications, Second Edition, Spon Press. ISBN: 978-04-153-1156-4.

5. Karl Terzaghi, Soil Mechanics in Engineering Practice, Warren Press. ISBN: 978-14-465-1039-1.

| **Name of The Course** | **Hydrology & Hydraulic Systems** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE2009** | | | |
| **Prerequisite** | BTCE2001 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To understand the concept of weather and hydrology.
2. To have an idea about precipitation and abstraction.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the importance of hydrology. |
| **CO2** | Explain diurnal and monsonic wind systems. |
| **CO3** | Process and analyze precipitation data. |
| **CO4** | Distinguish between centrifugal pump and Reciprocating pump. |
| **CO5** | Determine the specific speed for different types of turbines. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction**<br><br>**9 lecture hours** |
| Definition – Development of hydrology – hydrologic design – Hydrologic failures – Importance in Engineering – Hydrological budget. |
| **Unit II: Hydro Meteorology**<br><br>**9 lecture hours** |

| |
|---|
| Weather and hydrology – General circulation Temperature humidity – Wind – Diurnal and monsonic wind systems. |
| **Unit III: Precipitation and Abstraction**<br><br>**9 lecture hours** |
| Formation of precipitation – forms of precipitation – types of precipitation – Rainfall measurement – gauges – recorders – processing precipitation data – check for consistency – supply of missing data – Aerial mean mass curve technique – Intensity duration frequency curves. Process of evaporation, transpiration – Infiltration factors affecting evaporation – Measurement of evaporation and infiltration indices – Horton's equation. |
| **Unit IV: Pumps**<br><br>**9 lecture hours** |
| Centrifugal pump – velocity triangle – characteristic curves – specific speed – applications – Reciprocating pump – types – Indicator diagram – acceleration and friction – air vessels. |
| **Unit V: Turbines**<br><br>**9 lecture hours** |
| Classification – Pelton Turbine – Francis Turbine – Kaplan Turbine - velocity triangle – characteristic curves – specific speed. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1.Subramanya K. (2008), Engineering Hydrology, Tata McGraw Hill Co., Graw Hill Co. ISBN: 9780074624494.
2. Varshney R.S. (2012), Engineering Hydrology, Nem Chand & Brothers Publishers. ISBN: 8185240688.
3. Das (2009), Hydrology & Soil Conservation Engineering, Prentice-Hall of India. ISBN: 9788120335868.
4. Modi P. N. and Seth S. M. (2011), Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Publications, ISBN-9788189401269.
5. Bansal R. K. (2010), A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publication, ISBN-9788131808153.

| **Name of The Course** | **Structural Analysis Lab** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3005** | | | |
| **Prerequisite** | BTCE3001 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To know the concept and procedure of different type of method to find slope and deflection for different type of structures.
2. To understand the advantage and disadvantage of different types of methods used for find slope.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Measure deflection of a simply supported beam and verify Clark-Maxwell's theorem. |
| **CO2** | Determine the Flexural Rigidity of a given beam. |
| **CO3** | Verify the Moment - area theorem for slope and deflection of a given beam. |
| **CO4** | Determine deflection studies for a continuous beam. |
| **CO5** | Visualize the behaviour of two hinged arch and three hinged arch. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. Deflection of a simply supported beam and verification of Clark-Maxwell's theorem.
2. To determine the Flexural Rigidity of a given beam.
3. To verify the Moment - area theorem for slope and deflection of a given beam.
4. Deflection of a fixed beam and influence line for reactions.
5. Deflection studies for a continuous beam and influence line for reactions.
6. Study of behaviour of columns and struts with different end conditions.
7. Experiment on three hinged arch.
8. Experiment on two hinged arch.
9. Deflection of a statically determinate pin jointed truss.
10. Unsymmetrical Bending of curved beam.

**Suggested Reading**

1. Vazirani & Ratwani (2003), Analysis of Structures, Vol. 1 & II, Khanna Publishers, ISBN: 0125249853.
2. S. Ramamrutham (2004), Theory of Structures, 5thEdition, Dhanpat Rai Publications, ISBN: 978041528091
3. C. S. Reddy (2010), Structural Analysis, 3rd Edition, Tata McGraw Hill, ISBN:9780070702769.
4. Kenneth M. Leet, Gilbert A, Uang C. M. (2010), Fundamentals of Structural Analysis, 4th Edition, Tata McGraw Hill,ISBN:9780071289382

| **Name of The Course** | **Construction Engineering Lab** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BTCE2006** | | | | |
| **Prerequisite** | BTCE2003 | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | | **L** | **T** | **P** | **C** |
| | | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To know the concept and procedure of different type of test conducted on cement, aggregate and concrete.
2. To understand the properties of different building materials and their Civil Engineering Significance.
3. To understand the IS Code provision of testing different types of building materials.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Identify the suitability of materials for construction work. |
| **CO2** | Determine the fineness of cement by Blain air permeability apparatus. |
| **CO3** | Determine the specific gravity of given sample of OPC. |
| **CO4** | Determine the consistency of the concrete mixes for different W/C ratio by slump test with and without admixture. |
| **CO5** | Cast concrete cubes and determine compressive strength of concrete. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. To determine the water content required producing a cement paste of normal consistency and also determining initial and final setting time of a given cement sample.
2. To determine the fineness of cement by Blain air permeability apparatus.
3. To determine the specific gravity of given sample of OPC.
4. To determine the particle size distribution of fine and coarse aggregate by sieve analysis method.
5. Determination of specific gravity of coarse and fine aggregate.
6. To determine the silt content in the given sample of fine aggregate and also determine necessary adjustment for the bulking of fine

aggregate and draw curve between water content and bulking.
7. To determine the consistency of the concrete mixes for different W/C ratio by slump test with and without admixture.
8. To determine the workability of concrete mix of given proportion by compaction factor test.
9. To cast concrete cubes and to determine compressive strength of concrete by non-destructive and destructive method of testing.

**Suggested Reading**

1. Rangwala, (2011), Engineering Materials, 38th edition, Charotar Publishing House Pvt. Ltd. ISBN: 978-93-80358-26-0.
2. Ashok Kumar Jain, Dr. B.C. Punmia, Arun Kumar Jain (2009), Building Construction, Laxmi Publications Pvt. Ltd, ISBN: 978-81-318-0428-5.
3. M. L. Gambhir, (2009), Concrete Technology, Tata McGraw Hill Education, ISBN: 978-00-701-5136-9.
4. P. C. Varghese, (2009), Engineering Materials, 1st edition, PHI Learning, ISBN: 978-81-203-2848-8.

| **Name of The Course** | **Geotechnical Engineering Lab** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BTCE3006** | | | | |
| **Prerequisite** | BTCE3003 | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 0 | 0 | 2 | 1 | |

**Course Objectives**

1. To impart the fundamental concepts of soil mechanics.
2. To understand the bearing capacity.
3. To know the importance of index properties like grain size, consistency limits, soil classification.
4. To understand the concept of compaction and consolidation of soils.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Give an engineering classification of a given soil. |
| **CO2** | Understand the principle of effective stress, and then calculate stresses that influence soil behavior. |
| **CO3** | Determine soil deformation parameters, and calculate settlement magnitude and rate of settlement. |
| **CO4** | Specify soil compaction requirements. |
| **CO5** | Conduct laboratory tests, and obtain soil properties and parameters from the test observations and results. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. To determine moisture content of soil
2. To determine the specific gravity of soil fraction passing 4.75mm I.S sieve by density bottle/Pycnometer bottle
3. To determine the grain size distribution curve for given soil sample by sieve analysis and hydrometer analysis.
4. To determine the consistency limits (i.e Liquid limit, Plastic limit & Shrinkage limit)of given samples
5. To determine in-situ density of compacted soils by using core cutter & pouring cylinder methods.
6. To determine the relative density of given coarse grained materials
7. To determine the maximum dry density and optimum moisture content for the given soil sample.
8. To determine coefficient of permeability of given soil sample by constant head and variable head method.
9. To determine unconfined compressive strength of a given soil sample
10. To determine shear strength of a given soil specimen using vane shear apparatus
11. To determine shear strength of a given soil specimen using direct shear apparatus
12. To determine the shear parameters of soil by Undrained Triaxial Test.

**Suggested Reading**

1. K.R.Arora (2011), Soil Mechanics and Foundation Engineering, Standard Publishers Distributors, Delhi, ISBN: 978-81-801-4112-6.
2. Arun Kr. Jain, B.C. Punmia, Ashok Kr. Jain (2005), Soil Mechanics and Foundations, Sixteenth Edition, Laxmi Publications. ISBN: 978-81-700-8791-5.
3.Gopal Ranjan, A.S.R Rao (2000), Basic and Applied Soil Mechanics 2nd Edition, New Age International. ISBN: 978-81-224-1223-9.
4. William Powrie, Soil Mechanics: Concepts and Applications, Second Edition, Spon Press. ISBN: 978-04-153-1156-4.
5. Karl Terzaghi, Soil Mechanics in Engineering Practice, Warren Press. ISBN: 978-14-465-1039-1.

| **Name of The Course** | **PBL-2 (Project Management)** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE2014** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems pertaining to civil engineering domain.
2. To foster collaborative learning skills.
3. To develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Identify, formulate, and solve engineering problems. |
| **CO2** | Understand planning and scheduling of a project. |
| **CO3** | Submit a project report comprising of the application and feasibility of the project. |
| **CO4** | Work and communicate efficiently in multidisciplinary teams. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| **Components** | **Internal Evaluation** | | **Final Evaluation** | |
|---|---|---|---|---|
| | **Online Examination and Viva voice - I** | **Online Examination and Viva voice - II** | **Project Report** | **Online Examination and Viva voice (ETE)** |
| **Marks** | **25** | **25** | **20** | **30** |
| **Total Marks** | **100** | | | |

**List of Projects:**

1. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 750 sq. ft.
2. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 850 sq. ft.
3. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1000 sq. ft.
4. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1100 sq. ft.
5. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 800 sq. ft.
6. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 900 sq. ft.
7. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 950 sq. ft.
8. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1050 sq. ft.
9. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1150 sq. ft.

10. Planning and scheduling for a new project on constructing a two storied masonry building with carpet area 1200 sq. ft.
11. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1250 sq. ft.
12. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1300 sq. ft.
13. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1350 sq. ft.
14. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1400 sq. ft.
15. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 650 sq. ft.
16. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 725 sq. ft.
17. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 825 sq. ft.
18. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 925 sq. ft.
19. Planning and scheduling for a new project on construction of a two storied masonry building with carpet area 1125 sq. ft.

**Suggested Reading**

1. Jha Kumar Neeraj (2013), "Construction Project Management", Pearson Education India. ISBN9788131732496.
2. Chitkara, K. K. (2010), "Construction Project Management: Planning, Scheduling and Controlling", Tata McGraw-Hill Publishing Company Limited. ISBN 9780070680753.
3. R. L. Peurifoy and C. J. Schexnayder (2008), "Construction Planning, Equipment and Methods", Tata McGraw-Hill Publishing Company Limited. ISBN 9780073401126.

| **Name of The Course** | **Design of Reinforced Concrete Structures** |
|---|---|
| **Course Code** | **BTCE3002** |
| **Prerequisite** | BTCE2008, BTCE3001 |
| **Co-requisite** | - |
| **Anti-requisite** | - |

| **L** | **T** | **P** | **C** |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives**

1. To make the students to learn design of beams by working stress method.
2. To enable the students to understand the limit state method of design of beams, columns and slabs.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the behavior of structural members and the concept of design. |
| **CO2** | Calculate moment of resistance for different types of RC beam section. |
| **CO3** | Design any RC beam by limit state method. |
| **CO4** | Understand the difference between one way slab and two way slab. |
| **CO5** | Know the concept of short column and long column. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: Material Properties and Design Concepts**<br><br>**9 lecture hours** |
|---|
| Material properties: Compressive strength, tensile strength, design stress-strain curve of concrete - modulus of elasticity - grades of concrete - different types and grades of reinforcing steel - design stress-strain curve of steel. Introduction to design concepts, elastic behaviour of rectangular section, under, balanced and over reinforced section. Deflection and cracking in beams and slabs using IS code provisions. Design of singly reinforced beams by working stress method. |
| **Unit II: Introduction to Limit State Design** |

| |
|---|
| **9 lecture hours** |
| Philosophy and principle of limit state design along with the assumptions, partial safety factors, characteristic load and strength. Introduction to stress block parameters, concept of balanced, under reinforced and over reinforced sections, limit state of collapse in flexure of rectangle and flanged sections with examples. Limit state of collapse in shear and torsional strength of sections with examples. |
| **Unit III: Limit state design of beams**<br><br>**9 lecture hours** |
| Design principles and procedures for critical sections for bending moment and shear forces. Flexural and shear design example of singly and doubly reinforced simply supported and cantilever beams using the codal provision. Detailing of longitudinal and shear reinforcement, anchorage of bars, check for development length. Reinforcement requirements, slenderness limits for beams for lateral stability. Flexural and shear design of simply supported T and L beams. Design of rectangular section for torsion. |
| **Unit IV: Limit State Design of Slabs**<br><br>**9 lecture hours** |
| Introduction to one way and two way slabs, design of one way cantilever, simply supported and continuous slab, design of two way slabs. |
| **Unit V: Limit State Design of Compression Members**<br><br>**9 lecture hours** |
| General design aspects of compression members, Design of short axially loaded columns with reinforcement detailing, Design of columns with uniaxial bending and biaxial bending using SP- 16 charts, Design of long column. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Gambhir, M.L., (2011), "Fundamentals of Reinforced Concrete Design", Prentice-Hall of India. ISBN: 9788120330481.
2. S Unnikrishna Pillai &Devdas Menon, (2005), Reinforced Concrete Design, Tata Mcgraw Hill, ISBN: 9780070141100.
3. Varghese, P.C., (2009), Limit State Design of Reinforced Concrete, 2nd ed. ISBN: 9788120320390.

| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Water Supply and Treatment Systems** | | | |
| **Course Code** | **BTCE2010** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To make the students to understand the basic principles and concepts of unit operations and processes involved in water treatment.
2. To enable the students to learn design of unit operations and processes involved in water treatment.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Define water demand. |
| **CO2** | Understand about treatment of raw water. |
| **CO3** | Differentiate between slow sand filters and rapid sand filters. |
| **CO4** | Understand disinfection processes in water treatment. |
| **CO5** | Explain water supply networks. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Water sources- classification and Distribution** |

| |
|---|
| **8 lecture hours** |
| **8 lecture hours** |
| Water demand, Factors governing water demands and seasonal variations, Effect of population dynamics on water demand, Principles for forecasting of water-demand and its calculations, Self-purification of surface water bodies – Oxygen sag curve, permissible values for drinking water |
| **Unit II: Water Treatments Units**<br><br>**8 lecture hours** |
| Physicochemical Principles applied in water treatment, Unit operations, principles and processes for pretreatment and treatment of raw water, pre-chlorination and chlorination, principles and objectives for designing chlorination systems, General design considerations for designing water treatment plants. |
| **Unit III: Unit Operations & Processes**<br><br>**8 lecture hours** |
| Principles, functions and design of screen, grit chambers, flash mixers, flocculators, sedimentation tanks and sand filters- Slow sand and rapid sand filters, layouts – Flash mixer – Clariflocculator – Slow sand and rapid sand filters |
| **Unit IV: Disinfection Processes in Water treatment**<br>**8 lecture hours** |
| Principles, Objectives, Unit Operations & Advanced Processes in Water treatment, Disinfection – Aeration – iron and manganese removal, Defluoridation and demineralization – Water softening |
| **Unit V: Water supply systems**<br><br>**9 lecture hours** |
| Various water supply systems - Water supply networks - Various water storage systems |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Garg S.K. (2010), Environmental Engineering Vol. I Water Supply Engineering, Khanna Publishers. ISBN: 9788174091208
2. H.S.Peavy, D.R.Rowe & George Tchobanoglous (2005), Environmental Engineering, McGraw-Hill Company, New Delhi. ISBN: 9789380358246
3. Nathanson, Jerry A. (2007), Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control, 5th ed., PHI Learning Private Limited ISBN: 978-81-203-3836-4
4. Rangwala (1999), Water supply & Sanitary Engineering, Charotar Publishing House, Anand-16th Edition. ISBN: 9788185594590
5. Metcalf and Eddy (2003), Wastewater Engineering, Treatment and reuse, Tata McGraw-Hill Edition, Fourth edition. ISBN:9780070495395

| **Name of The Course** | **Highway Engineering** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE2015** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To impart the knowledge in Highway Geometrics, Traffic Engineering, materials, construction and design of pavements.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Design various geometric elements of highways. |
| **CO2** | Understand the procedure to collect the traffic data for design and traffic management. |
| **CO3** | Test the highway materials as per IS/IRC guidelines. |
| **CO4** | Do structural design of flexible and rigid pavements. |
| **CO5** | Know various highway constructions techniques and its maintenance. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Highway and Traffic Planning**<br><br>**8 lecture hours** |
| Introduction to Transportation modes – Highway alignment and field surveys – Master Plan – Transport economics – Traffic Studies – Volume, speed, origin and destination studies.<br>Introduction to Multi-modal Transportation, Automated Transport systems, High urban transport, Impact of transport on environment. |
| **Unit II: Highway Geometrics**<br><br>**14 lecture hours** |
| Highway classification (Rural and Urban roads), Road Geometrics – Highway cross section elements – camber – Sight Distance, Horizontal Alignment Design, Super Elevation, Extra widening, Transition curves, Set back distance, Design of Vertical curves. |
| **Unit III: Traffic Engineering**<br><br>**6 lecture hours** |
| Traffic characteristics, road user & vehicular characteristics, traffic studies, traffic operations, traffic control devices, intelligent transport systems, Intersections, Interchanges, Parking Layout & Road signs. |
| **Unit IV: Highway Materials and Construction**<br><br>**8 lecture hours** |
| Material requirement for pavements – Soil classification for Highway – Soil tests – CBR and Plate Load Test, Aggregate – materials testing and specification, Bitumen – material testing and specification construction of bituminous and rigid pavements, Highway Maintenance – Material recycling |
| **Unit V: Highway Design**<br><br>**9 lecture hours** |
| Pavement Analysis – Factors affecting pavement thickness – Soil – Wheel load – Temperature – environmental factors; Flexible Pavement Design – Axle Load surveys – CBR method of Design, Rigid Pavement Design – IRC method |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Khanna.S.K and Justo. C.E.G., (2011), Highway Engineering, Ninth Edition.
2. Kadiyali.L.R, and Lal.N.B, (2005), Principles and Practice of HighwayEngineering, Fourth Edition, Khanna Publishers, ISBN- 9788174091659.
3. ChakroborthyPartha, and Das Animesh, (2003), Principles of Transportation Engineering, Eighth Printing, Prentice-Hall of India, ISBN-9788120320840.
4. Rao.G.V., (1996), Principles of Transportation and Highway Engineering, Tata McGraw-Hill Co, ISBN- 9780074623633.

| **Name of The Course** | **Transportation Engineering** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3010** | | | |
| **Prerequisite** | BTCE2015 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To teach the students about the different transportation systems.
2. To familiarise with various components involved in their respective modes and their basic design concepts.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Demonstrate the ability to identify the components of railway track, their functions, alignment and the station yards. |
| **CO2** | Understand the requirements of railway alignment |

| | |
|---|---|
| **CO3** | Recognize and identify the requirement of an airport and the principle involved in it. |
| **CO4** | Design runway and taxiway. |
| **CO5** | Learn to classify the harbours and demonstrate the ability to identify the components of a dock. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction to Railway Engineering**<br>**8 lecture hours** |
| History and administrative setup of Indian Railways; rail gauges, permanent way – functions, requirements, sections in embankment and cutting, stresses in different components of track, Types of joints and fastenings. |
| **Unit II: Track Geometrics and Safety**<br>**8 lecture hours** |
| Requirements of Railway alignment, vertical alignment and horizontal alignment, points and crossings – terminologies, Turnouts – Types and design aspects, Signals classification and their functions, train operation control systems, interlocking of tracks. |
| **Unit III: Introduction to airports and Aircraft Characteristics**<br>**8 lecture hours** |
| Air transport development in India, national and international organizations in air transport, aircraft characteristics and their impact on planning of an airport, selection of site for an airport, airport obstruction, imaginary surfaces, runway orientation clam period and wind coverage. |
| **Unit IV: Geometric Designs and Airport Traffic control Aids**<br>**8 lecture hours** |
| Runway and taxiway geometric designs, exit taxiway, its design and fillet curves, runway configuration, separation clearance, design of apron and their layout.<br>Visual aids, marking and lighting of runway and apron area, wind and landing direction indicator. |
| **Unit V: Docks and Harbour Engineering**<br>**8 lecture hours** |
| Historical development in India , tides, winds & waves, docks, harbours, break waters, jetties, landing stages & wharves, dry docks, transit sheds, cargo handling, inland water transport, Maintenance. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**


1. Chandra.S., and Agarwal. M.M., (2007), Railway Engineering, Oxford University Press India, ISBN- 9780195687798.
2. Rangwala.S.C., Rangwala.P.S., (2008), Airport Engineering, Charotar Publishing House Pvt. Limited, ISBN-9788185594972.
3. Oza.H.P., and Oza. G.H., (2011), Dock and Harbour Engineering, Sixth Edition, Charotar Publishing House Pvt., ISBN-9789380358383.


| **Name of The Course** | **CAD Lab - I (AUTOCAD)** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3008** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 4 | 2 |

**Course Objectives**

1. To enable the students to understand the regulations as per National Building Code.
2. To make the students to learn the functional requirements and building rules.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand AUTOCAD commands and draw lines, circles and different types of polygon. |
| **CO2** | Draw plan, elevation and cross-sectional views of one storey residential building. |
| **CO3** | Draw staircases. |
| **CO4** | Draw plan, elevation and cross-sectional views of two storey residential building. |
| **CO5** | Draw plan, elevation and cross-sectional views of workshop with trussed roof. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

List of Experiments:

1. AUTOCAD commands, drawing of lines, circles and different types of polygon.
2. Drawing plan, elevation and cross-sectional views of one storey residential building.
3. Drawing of staircases.
4. Drawing plan, elevation and cross-sectional views of two storey residential building.
5. Drawing plan, elevation and cross-sectional views of five story commercial building.
6. Drawing plan, elevation and cross-sectional views of three story hospital building.
7. Drawing plan, elevation and cross-sectional views of ten story college building.
8. Drawing plan, elevation and cross-sectional views of workshop with trussed roof

**Suggested Reading**

1. V. B. Sikka (2012), "Civil Engineering Drawing", S.K.Kataria& Sons, New Delhi. ISBN: 978-93-5014-272-1

2. N. Kumaraswamy (2012), A.Kameswara Rao "Building Planning & Drawing", Charotar Publishing House Pvt. Ltd. ISBN: 9789380358581

3. AUTOCAD Manuals

| **Name of The Course** | **Transportation Engineering Lab** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3011** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To enable the students to know testing of different highway materials as per IS/IRC guidelines.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand aggregate crushing value test. |
| **CO2** | Explain aggregate impact test. |
| **CO3** | Perform Los Angeles abrasion test. |
| **CO4** | Understand ductility test of bitumen. |
| **CO5** | Explain California Bearing ratio test. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

List of Experiments:

1. Aggregate Crushing Value Test
2. Aggregate Impact Test
3. Los Angeles Abrasion Test
4. Shape Test
5. Penetration Test of Bitumen
6. Ductility Test of Bitumen
7. Softening Point Test of Bitumen
8. Flash and Fire Point Test of Bitumen
9. Viscosity Test of Bitumen
10. Spot Test
11. California Bearing Ratio Test

**Suggested Reading**

1. Khanna.S.K., and Justo. C.E.G., (2011), Highway Engineering, Ninth Edition, Nem.

2. Kadiyali.L.R., and Lal.N.B., (2005), Principles and Practice of Highway Engineering, Fourth Edition, Khanna Publishers, ISBN- 9788174091659.
3. ChakroborthyPartha, and Das Animesh, (2003), Principles of Transportation Engineering, Eighth Printing, Prentice-Hall of India, ISBN-9788120320840
4. Rao.G.V., (1996), Principles of Transportation and Highway Engineering, Tata McGraw-Hill Co, ISBN- 9780074623633.

| Name of The Course | Water Quality Analysis Lab | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE2012** | | | |
| **Prerequisite** | BTCE2010 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To enable the students to understand the basic principles and concepts of unit operations and processes involved in water treatment.
2. To make the students to know turbidity test of a given water sample.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Determine pH of a given water sample. |
| **CO2** | Determine total solids, suspended solids, dissolved solids and volatile solids in wastewater. |
| **CO3** | Determine turbidity and specific conductivity of the given water samples. |
| **CO4** | Determine alkalinity of a given water sample |
| **CO5** | Determine chloride concentration of a given water sample. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. To determine the pH of a given water sample.
2. To determine the total solids, suspended solids, dissolved solids and volatile solids in wastewater.
3. To determine the turbidity and specific conductivity of the given water samples.
4. To determine the Alkalinity of given water sample.
5. To determine total hardness, permanent hardness and temporary hardness for given water sample.
6. To determine the chloride concentration of a given water sample.
7. To determine amount of sulphates in a given sample
8. To determine the dissolved oxygen content in a given water sample.
9. To determine BOD of the given wastewater sample.
10. To determine the COD of given sample.
11. To determine the optimum dosage of coagulant for turbidity removal of a given water sample.

**Suggested Reading**

1. Garg S.K. (2010), Environmental Engineering Vol. I Water Supply Engineering, Khanna Publishers. ISBN: 9788174091208
2. H.S.Peavy, D.R.Rowe & George Tchobanoglous (2005), Environmental Engineering, McGraw-Hill Company, New Delhi. ISBN: 9789380358246
3. Nathanson, Jerry A. (2007), Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control, 5th ed., PHI Learning Private Limited ISBN: 978-81-203-3836-4
4. Rangwala (1999), Water supply & Sanitary Engineering, Charotar Publishing House, Anand-16th Edition. ISBN: 9788185594590
5. Metcalf and Eddy (2003), Wastewater Engineering, Treatment and reuse, Tata McGraw-Hill Edition, Fourth edition. ISBN:9780070495395

| Name of The Course | PBL-3 |
|---|---|
| **Course Code** | **BTCE3007** |

| Prerequisite | BTCE3001, BTCE3002, BTCE3003, BTCE3004 | | | |
|---|---|---|---|---|
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems pertaining to civil engineering domain.
2. To foster collaborative learning skills.
3. To develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Identify, formulate, and solve engineering problems. |
| **CO2** | Understand planning and scheduling of a project. |
| **CO3** | Submit a project report comprising of the application and feasibility of the project. |
| **CO4** | Work and communicate efficiently in multidisciplinary teams. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| Components | Internal Evaluation | | Final Evaluation | |
|---|---|---|---|---|
| | Online Examination and Viva voice - I | Online Examination and Viva voice - II | Project Report | Online Examination and Viva voice (ETE) |
| Marks | 25 | 25 | 20 | 30 |
| Total Marks | 100 | | | |

**List of Projects:**

1. Analyze statically indeterminate structures by strain energy method.
2. Design a two storey residential building.
3. Design a five storey RCC commercial building.
4. Study compressibility and consolidation of soil.
5. Study shear strength of soil.
6. Study waste water treatment plant.

**Suggested Reading**

1. Vazirani & Ratwani (2003), Analysis of Structures, Vol. 1 & II, Khanna Publishers, ISBN: 0125249853.

2. Gambhir, M.L., (2011), "Fundamentals of Reinforced Concrete Design", Prentice-Hall of India. ISBN: 9788120330481.

3. Arun Kr. Jain, B.C. Punmia, Ashok Kr. Jain (2005), Soil Mechanics and Foundations, Sixteenth Edition, Laxmi Publications. ISBN: 978-81-700-8791-5.

4. Garg.S.K, (2010), Environmental Engineering-Sewage Disposal and Air Pollution Engineering, 1st Edition, Khanna Publishers, ISBN- 978-81-740-9230-4.

| Name of The Course | PBL-4 (PRIMA VERA) | | | |
|---|---|---|---|---|
| Course Code | BTCE3040 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems pertaining to civil engineering domain.
2. To foster collaborative learning skills.
3. To develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Identify, formulate, and solve engineering problems. |
| **CO2** | Understand planning and scheduling of a project. |
| **CO3** | Submit a project report comprising of the application and feasibility of the project. |
| **CO4** | Work and communicate efficiently in multidisciplinary teams. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| **Components** | **Internal Evaluation** | | **Final Evaluation** | |
|---|---|---|---|---|
| | **Online Examination and Viva voice - I** | **Online Examination and Viva voice - II** | **Project Report** | **Online Examination and Viva voice (ETE)** |
| **Marks** | **25** | **25** | **20** | **30** |
| **Total Marks** | **100** | | | |

**List of Projects:**

1. Determination of volume of excavation of earth.
2. Estimation for concrete and steel in footings.
3. Form work required for footings.
4. Estimation for brick walls and plastering.
5. Form work required for columns including scaffolding and shuttering.
6. Estimation for concrete and steel in columns.
7. Form work required for slabs including scaffolding and shuttering.
8. Estimation for concrete and steel in slabs.
9. Form work required for beams including scaffolding and shuttering.
10. Estimation for concrete and steel in beams.
11. Rate analysis for various items of works.
12. Preparation of bills.
13. Studies of PWD and CPWD practices.
14. Bar bending schedule.
15. Valuation of the building.

**Suggested Reading**

1. B.N. Datta (2010), Estimating and costing, USBPD. ISBN 9788174767295.
2. Rangwala (2011), Specifications of Estimating, Costing and Valuation, Charotar Publishing House Pvt. Ltd. ISBN 9789380358543.
3. Vazirani, V. N. (2013), Civil Engineering Estimating Costing & Valuation, Khanna publishers. ISBN 9788174091277.

| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Industrial Internship - I** | | | | |
| **Course Code** | **BTCE3041** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 0 | 0 | 0 | 1 | |

**Course Objectives**

1. To gain first-hand experience of working as an engineering professional, including the technical application of engineering knowledge.
2. To experience the discipline of working in a professional organization and multidisciplinary team.
3. To develop technical, interpersonal and communication skills.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Apply engineering knowledge in solving real-life problems. |
| **CO2** | Attain new skills and be aware of the state-of-art in engineering disciplines of their own interest. |
| **CO3** | Get exposure to real-life-working environment & practices, and to attain the professionalisms. |
| **CO4** | Work with multi-tasking professionals and multidisciplinary team. |
| **CO5** | Prepare a technical report, to improve presentation and other soft skills. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

Exposure to real life problems at various reputed industries engaged in areas of Civil Engineering.

**Mode of Evaluation:**

The evaluation of this training shall be included in the next semester evaluation. The student will be assigned a faculty guide who would be the supervisor of the student. The faculty will be identified before the end of the examination.

Students have to prepare an exhaustive technical report of the internship undertaken which will be duly signed by the officer under whom internship was taken in the industry/ organization. The covering format shall be signed by the concerned faculty in-charge of the student. The officer-in-charge would also give his rating of the student in a sealed envelope to the Dean of the SOCE. The student at the end of internship will present his report about the internship before a committee constituted by the Dean of the School which would be comprised of at least three members comprising of the Division Chair/Program Chair. The students guide would be a special invitee to the presentation. The seminar session shall be an open house session. The internal marks would be the average of the marks given by each member of the committee separately in a sealed envelope to the Dean.

The marks by the external examiner would be based on the report submitted by the student which shall be evaluated by the external examiner and cross examination done of the student concerned. Not more than three students would form a group for such industrial internship.The final evaluation of the Industrial Internship will be based on the following criteria:

1. Presentation and contents of the report demonstrating well developed communication skill.
2. The professionalism displayed by the student during industrial training including the scope of quality industrial training attained.
3. Contribution of the employer in providing quality training and relevance of the student's industrial training to their degree.
4. Marks/grades for this course will be withheld until students complete the training. Without this mark/grade students cannot graduate.

| Components | Internship Progress Report | | Final Evaluation | |
|---|---|---|---|---|
| | Internal Supervisor | Industry Supervisor | Project Report | Presentation and Viva voice |
| Marks | 25 | 25 | 25 | 25 |
| Total Marks | 50 | | 50 | |
| Overall Marks | 100 | | | |

| Name of The Course | Design of Steel Structures | | | |
|---|---|---|---|---|
| Course Code | BTCE3009 | | | |
| Prerequisite | BTCE3001 | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To enable the students to understand the concepts of steel design.
2. To make the students to learn different types of pitched roofs.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| CO1 | Understand different types of structural rolled steel sections and their properties and design of connections. |
| CO2 | Design laterally supported and laterally unsupported steel beams. |
| CO3 | Design built up column sections, lacings, battens, column bases and tension members. |
| CO4 | Design plate girders and understand curtailment of flange plates and stiffeners. |
| CO5 | Analyze and design roof trusses and purlins. |
| CO6 | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction and Design of Connection** **8 lecture hours** |
| Introduction, Types and properties of structural rolled steel sections, Design of connections – Riveted - Welded - Bolted – Solution of simple problems. |
| **Unit II: Design of beams** **9 lecture hours** |
| Simple and built-up beams – design of laterally supported and unsupported beams - concept of shear. |
| **Unit III: Design of Compression Members and Tension Members** **9 lecture hours** |
| Design of column – built up section – single and double lacing – batten – Column bases – design of tension members. |
| **Unit IV: Plate Girders** **10 lecture hours** |
| Plate girders - design of plate girders - curtailment of flange plates – Concept of stiffeners and splices |
| **Unit V: Roof Trusses** **8 lecture hours** |
| Types of roof trusses - Calculation of dead load, live load, wind load – Analysis and design of roof truss – Design of purlins. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Vajrani V. N., Ratwani M. M. and Mehra H. (2012), Design and Analysis of Steel Structures, 18th Edition, Oscar Publications, ISBN: 9788174092953.
2. Syal I. C. (2009), Design of Steel Structures, Standard Publishers Distributors, New Delhi, ISBN: 9788180141270.
3. Ramchandra (2006), Non Linear Analysis of Steel Structures, Standard Publishers Distributors, ISBN:9788180140785.
4. IS: 800-2007 & Steel Table.

| **Name of The Course** | **Waste Water Treatment & Disposal Systems** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3004** | | | |
| **Prerequisite** | BTCE2010 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To teach students the basic principles and concepts of unit operations and processes involved in wastewater treatment.
2. To develop student's skill in the basic design of unit operations and processes involved in wastewater treatment.
3. To develop a student's skill in evaluating the performance of wastewater treatment plants.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Demonstrate an ability to recognize the type of unit operations and processes involved in wastewater treatment plants. |
| **CO2** | Demonstrate an ability to choose the appropriate unit operations and processes required for satisfactory treatment of wastewater. |
| **CO3** | Demonstrate an ability to design individual unit operation or process |

| | |
|---|---|
| | appropriate to the situation by applying physical, chemical, biological and engineering principles. |
| **CO4** | Demonstrate ability in design of wastewater treatments units in a cost effective and sustainable way and evaluate its performance to meet the desired health and environment related goals. |
| **CO5** | Recognize the importance of wastewater treatment to protect the water resources. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Wastewater Treatment**<br><br>**8 lecture hours** |
| Physical, chemical and biological principles involved in wastewater treatment and designing of unit-operations and processes. Permissible standards for wastewater disposal |
| **Unit II: Pre and Primary Treatment**<br><br>**9 lecture hours** |
| Objectives-Unit operations and processes-Principles, functions and design of flash mixers, screens, sedimentation tanks and sand filters-Disinfection-Aeration, grit chambers and primary sedimentation tanks. |
| **Unit III: Secondary Treatment**<br><br>**7 lecture hours** |
| Secondary Treatment-Activated Sludge Process and Trickling filters; other treatment methods-Stabilization Ponds and Septic Tanks-Advances in Sewage Treatment. |
| **Unit IV: Sewage Disposal and Sludge Management**<br><br>**8 lecture hours** |
| Methods-Dilution-Self-purification of surface water bodies-Oxygen Sag Curve-Land disposal-Sewage Farming-Deep well injection-Soil dispersion system-Thickening-Sludge digestion-Bio-gas recovery, Drying beds-Conditioning and Dewatering-Sludge disposal. Introduction to solid waste management, landfills and EIA. |
| **Unit V: Waste Disposal System**<br><br>**8 lecture hours** |
| Wastewater Treatment-Typical layouts-Screens-Grit Chamber-Sedimentation tanks-Trickling filter-Activated Sludge, sludge Digester-Septic tanks-Soil Dispersion System-Waste Stabilization pond. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Garg.S.K, (2010), Environmental Engineering-Sewage Disposal and Air Pollution Engineering, 1st Edition, Khanna Publishers, ISBN- 978-81-740-9230-4.
2. Metcalf & Eddy, (2002), Wastewater Engineering Treatment & Reuse, Tata McGraw-Hill Education, ISBN: 978-00-704-9539-5
3. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, (2001), Environmental Engineering, Tata McGraw-Hill Education, ISBN No: 978-00-710-0231-8.
4. Hammer & Hammer Jr., Water and Wastewater Technology, 7th Edition, ISBN-978-81-203-4601-7.

| **Name of The Course** | **CAD Lab - II (STAAD PRO) (Skill Course-2)** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3013** | | | |
| **Prerequisite** | BTCE3001, BTCE3002 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **0** | **0** | **4** | **2** |

**Course Objectives**

1. To teach the students to understand the details of STAAD – PRO software package.
2. To enable the students to know the behaviour of RCC structures.
3. To enable the students to design different components of structures

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the details of STAAD – PRO software package. |
| **CO2** | Know the behavior of RCC structures. |
| **CO3** | Know the bending moment diagram drawn in tension face and shear force diagram. |
| **CO4** | Design RCC beams and columns. |
| **CO5** | Analyze and design RCC portal frames. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. Analysis and design of simply supported RCC beam.
2. Analysis and design of cantilever RCC beam.
3. Analysis and design of continuous RCC beam.
4. Analysis and design of doubly reinforced RCC beam.
5. Analysis and design of RCC columns with different end conditions.
6. Analysis and design of RCC portal frames.

**Suggested Reading**

1. V. N. Vazirani & M. M. Ratwani, (1998), Analysis of Structures, Khanna Publishers

2. R. L. Jindal, (1996), Indeterminate Structures, Tata McGraw Hill Publishing House.

3. G. S. Pandit & Gupta S. P., (1998), Structural Analysis (A matrix approach), Tata McGraw Hill Publishing Ltd.

4. Wang C. K., (1996), Matrix Method of Structural Analysis, Jon Wiley publications.

| **Name of The Course** | **Design and Innovation** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3042** | | | |
| **Prerequisite** | BTCE3001, BTCE3002 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To teach the students to understand the details of STAAD – PRO software package.
2. To enable the students to know the behaviour of RCC structures.
3. To enable the students to design different components of structures

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the details of STAAD – PRO software package. |
| **CO2** | Know the behavior of RCC structures. |
| **CO3** | Know the bending moment diagram drawn in tension face and shear force diagram. |
| **CO4** | Design RCC beams and columns. |
| **CO5** | Analyze and design RCC portal frames. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**List of Experiments:**

1. Design of (G+2) masonry building.
2. Design of staircase.
3. Design of (G+3) RCC building.
4. Design of (G+4) RCC building.

**Suggested Reading**

1. V. N. Vazirani & M. M. Ratwani, (1998), Analysis of Structures, Khanna Publishers.
2. R. L. Jindal, (1996), Indeterminate Structures, Tata McGraw Hill Publishing House.
3. G. S. Pandit & Gupta S. P., (1998), Structural Analysis (A matrix approach), Tata McGraw Hill Publishing Ltd.
4. Wang C. K., (1996), Matrix Method of Structural Analysis, Jon Wiley publications.

| **Name of The Course** | **Remote Sensing & Geographical Information System** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3045** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 2 | 0 | 2 | 3 |

**Course Objectives**

1. To introduce the students to the basic concepts and principles of various components of remote sensing.

2. To provide an exposure to GIS and its practical applications in civil engineering.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know Principles of Remote Sensing. |
| **CO2** | Define GIS. |
| **CO3** | Understand the process of data entry. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **UNIT I: EMR and ITS Interaction with Atmosphere & Earth Material**<br>**5 lecture hours** |
| Definition of remote sensing and its components – Electromagnetic spectrum – wavelength regions important to remote sensing – Wave theory, Particle theory, Stefan-Boltzman and Wein's Displacement Law – Atmospheric scattering, absorption – Atmospheric windows – spectral signature concepts – typical spectral reflective characteristics of water, vegetation and soil. |
| **UNIT II: Geographic Information System**<br>**5 lecture hours** |
| Introduction – Maps – Definitions – Map projections – types of map projections – map analysis – GIS definition – basic components of GIS – standard GIS softwares – Data type – Spatial and nonspatial (attribute) data – measurement scales – Data Base Management Systems (DBMS). |
| **UNIT III: Data Entry, Storage And Analysis**<br>**5 lecture hours** |
| Data models – vector and raster data – data compression – data input by digitization and scanning – attribute data analysis – integrated data analysis – Modeling in GIS Highway alignment studies – Land Information System. |

**Suggested Reading**

1. Lillesand,T.M., Kiefer, R.W. and J.W.Chipman. "Remote Sensing and Image Interpretation" 5th Edition. John Willey and Sons Asia Pvt. Ltd., New Delhi, 2004.
2. Anji Reddy, M. "Textbook of Remote Sensing and Geographical Information System" 2nd edition. BS Publications, Hyderabad, 2001.
3. Lo. C.P.andA.K.W.Yeung, "Concepts and Techniques of Geographic Information Systems", Prentice Hall of India Pvt. Ltd., New Delhi, 2002
4. Peter A.Burrough, Rachael A. McDonnell, " Principles of GIS", Oxford University Press, 2000

**Remote Sensing & Geographical Information System Lab**

**Course Content**

1. Introduction of ARCGIS software

2. Storage of data
3. Geographical data modeling
4. Storage of geographical coordinates
5. Arc map – View & edit data, analyze data
6. Enhancement of images

| **Name of The Course** | **Project Work -1** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE9998** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 4 | 2 |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to civil engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
3. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Submit a project synopsis comprising of the application and feasibility of the project. |
| **CO2** | Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability. |
| **CO3** | Work and communicate efficiently in multidisciplinary teams. |
| **CO4** | Identify, formulate, and solve engineering problems. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| Components | Project Progress Report | Final Evaluation | |
|---|---|---|---|
| | Internal Supervisor | Project Report | Presentation and Viva voice |
| Marks | **20** | **30** | **50** |
| Total Marks | **100** | | |

| **Name of The Course** | **Advanced Structural Analysis** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3014** | | | |
| **Prerequisite** | BTCE3001 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To enable the students to understand the behaviour of indeterminate structures.
2. To help the students to know the concepts of elastic analysis and plastic analysis.
3. To teach students about the concepts of matrix analysis of structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the concept of moment distribution method. |
| **CO2** | Understand the concept of plastic analysis. |
| **CO3** | Use flexibility matrix method for analyzing beams and plane trusses. |
| **CO4** | Apply stiffness matrix method in the analysis of beams and plane trusses. |
| **CO5** | Understand approximate methods for analysis of multi-storeyed frames |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Moment distribution method** **8 Lecture Hours** |
| Moment distribution method - analysis of continuous beams and portals - bending moment and shear force diagram |
| **Unit II: Plastic Analysis** **8 Lecture Hours** |
| Plastic moment of resistance - shape factor - collapse load - analysis of continuous beams and portals. |
| **Unit III: Flexibility matrix** **8 Lecture Hours** |
| Concept of flexibility matrix - analysis of continuous beams - pin jointed plane trusses. |
| **Unit IV: Stiffness matrix** **8 Lecture Hours** |
| Stiffness matrix for beam element - analysis of continuous beams - pin jointed plane trusses. |
| **Unit V: Approximate Methods for Analysis of Multi-storeyed Frames** **8 Lecture Hours** |
| Substitute frame method - portal method - cantilever method and Kani's method. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Ashok K. Jain, (2009), Advanced Structural Analysis with Finite Element & Computer Applications, Nem Chand & Brothers, ISBN 978-81-852-4081-7.
2. Hibbeler, R. C. (2005), Structural Analysis (5th Ed.), Pearson Education India, ISBN-10: 0131470892.
3. S. S. Bhavikatti, (2005), Structural Analysis, 2nd edition, Vikas Publishing House, ISBN: 812-59-171-60.Rao C.S. (2006)

| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Industrial Internship - II** | | | | |
| **Course Code** | **BTCE4002** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 0 | 0 | 2 | 1 | |

**Course Objectives**

1. To gain first-hand experience of working as an engineering professional, including the technical application of engineering knowledge.
2. To experience the discipline of working in a professional organization and multidisciplinary team.
3. To develop technical, interpersonal and communication skills.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Apply engineering knowledge in solving real-life problems. |
| **CO2** | Attain new skills and be aware of the state-of-art in engineering disciplines of their own interest. |
| **CO3** | Get exposure to real-life-working environment & practices, and to attain the professionalisms. |
| **CO4** | Work with multi-tasking professionals and multidisciplinary team. |
| **CO5** | Prepare a technical report, to improve presentation and other soft skills. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

Exposure to real life problems at various reputed industries engaged in areas of Civil Engineering.

**Mode of Evaluation:**

The evaluation of this training shall be included in the next semester evaluation. The student will be assigned a faculty guide who would be the supervisor of the student. The faculty will be identified before the end of the examination.

Students have to prepare an exhaustive technical report of the internship undertaken which will be duly signed by the officer under whom internship was taken in the industry/ organization. The covering format shall be signed by the concerned faculty in-charge of the student. The officer-in-charge would also give his rating of the student in a sealed envelope to the Dean of the SOCE. The student at the end of internship will present his report about the internship before a committee constituted by the Dean of the School which would be comprised of at least three members comprising of the Division Chair/Program Chair. The students guide would be a special invitee to the presentation. The seminar session shall be an open house session. The internal marks would be the average of the marks given by each member of the committee separately in a sealed envelope to the Dean.

The marks by the external examiner would be based on the report submitted by the student which shall be evaluated by the external examiner and cross examination done of the student concerned. Not more than three students would form a group for such industrial internship.The final evaluation of the Industrial Internship will be based on the following criteria:

1. Presentation and contents of the report demonstrating well developed communication skill.
2. The professionalism displayed by the student during industrial training including the scope of quality industrial training attained.
3. Contribution of the employer in providing quality training and relevance of the student's industrial training to their degree.
4. Marks/grades for this course will be withheld until students complete the training. Without this mark/grade students cannot graduate.

| Components | Internship Progress Report | Final Evaluation | | |
|---|---|---|---|---|
| | **Internal Supervisor** | **Industry Supervisor** | **Project Report** | **Presentation and Viva voice** |
| Marks | **25** | **25** | **25** | **25** |
| Total Marks | **50** | | **50** | |
| Overall Marks | **100** | | | |

| **Name of The Course** | **Project Work -2** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE9999** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 0 | 0 | 4 | 2 |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to civil engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
3. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Submit a project synopsis comprising of the application and feasibility of the project. |
| **CO2** | Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability. |
| **CO3** | Work and communicate efficiently in multidisciplinary teams. |

| | |
|---|---|
| **CO4** | Identify, formulate, and solve engineering problems. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| Components | Project Progress Report | Final Evaluation | |
|---|---|---|---|
| | Internal Supervisor | Project Report | Presentation and Viva voice |
| Marks | **20** | **30** | **50** |
| Total Marks | **100** | | |

| **Name of The Course** | **Advanced Concrete Design** | | | | |
|---|---|---|---|---|---|
| **Course Code** | BTCE3015 | | | | |
| **Prerequisite** | BTCE3002 | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | | **L** | **T** | **P** | **C** |
| | | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To enable the students to learn the limit state method of design of concrete members.
2. To enable the students to understand the concepts of advanced concrete design for different structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Design different types of RC footings. |
| **CO2** | Design dog legged and open well stair case. |
| **CO3** | Design cantilever and counterfort retaining walls. |
| **CO4** | Understand the concept of yield line theory. |
| **CO5** | Design continuous beams and understand the concept of moment redistribution. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Design of Footings** **8 lecture hours** |
| Types of foundation - Design of isolated footing - combined footing – Concept of raft footing and well foundation |
| **Unit II: Design of Stair Cases** **8 lecture hours** |
| General specifications, Types of stair cases, Loads on stair cases, Effective span of stairs, Design of dog legged stair case, Design of open well stair case |
| **Unit III: Retaining Walls** **8 lecture hours** |
| General specifications, Forces acting on retaining walls, Stability consideration, Wall proportioning, Design of cantilever retaining walls and counterfort retaining walls. |
| **Unit IV: Yield Line Theory** **8 lecture hours** |
| Yield line pattern, Moment capacity along yield line, Ultimate load on slabs, Analysis by virtual work method and equilibrium method. |
| **Unit V: Design of Continuous Beams** **8 lecture hours** |
| Design of continuous RC beams, Plastic hinge, Moment redistribution. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. |

| |
|---|
| Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Gambhir, M.L., (2011), Design of Reinforced Concrete Structures, ISBN: 9788120331938.
2. Varghese, P.C., (2009), Advanced Reinforced Concrete Design, 2nd ed. ISBN: 9788120327870.
3. Jain, A.K., (1999) "Reinforced Concrete: Limit State Design 7th Edition, ISBN: 8185240663.
4. IS:456 (2000) & SP:16.

| **Name of The Course** | **Quantity Surveying and Estimating** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3016** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To enable the students to understand the types of estimates.
2. To make the students to understand rate analysis and process of preparation of bill of quantity.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Prepare a detailed estimate for different types of structures. |
| **CO2** | Estimate RCC and steel work. |
| **CO3** | Understand rate analysis & preparation of bills. |
| **CO4** | Determine the valuation of a building. |
| **CO5** | Understand schedule of rates. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I:Estimation of building**<br>**8 lecture hours** |
|---|
| Estimation of building works – Procedure of estimating, Types of estimates, detailed estimate of buildings including sanitary & electrical fittings. |
| **Unit II: Estimate of R.C.C and Steel works**<br>**8 lecture hours** |
| Estimate of R.C.C and Steel works - Scheduling - Slab - beam - column & trusses, Road – earthwork fully in banking, cutting, partly cutting & partly filling - Detailed estimate for WBM, Bituminous road. |
| **Unit III: Rate analysis & preparation of bills**<br>**8 lecture hours** |
| Rate analysis - preparation of bills – Data analysis of rates for various items of works – abstract estimates for Building projects – Introduction to software for Bill of Quantities & estimates. |
| **Unit IV: Valuation**<br>**8 lecture hours** |
| Valuation- rent fixation, tenders, - contracts – accounting procedure, measurement book, stores, cost & quality control – PWD & CPWD practice. |
| **Unit V: Detailed specifications and Schedule of Rates**<br>**8 lecture hours** |
| Specifications of various items of works - Schedule of Rates. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. B.N. Datta (2010), Estimating and costing, USBPD. ISBN 9788174767295.

2. Rangwala (2011), Specifications of Estimating, Costing and Valuation, Charotar Publishing House Pvt. Ltd. ISBN 9789380358543.

3. Vazirani, V. N. (2013), Civil Engineering Estimating Costing & Valuation, Khanna publishers. ISBN 9788174091277.

| Name of The Course | Bridge Engineering | | | |
|---|---|---|---|---|
| Course Code | BTCE3017 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To understand the design and codal concepts of different types of bridges.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| CO1 | Understand IRC Code |
| CO2 | Use Pigeauds curves for designing deck slab for T-beam Bridge. |
| CO3 | Understand Courbon's method of load distribution to analyze and design girders for T-beam Bridge. |
| CO4 | Design plate girder and steel truss bridges. |
| CO5 | Design piers and abutments |
| CO6 | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction and design of slab culvert**<br><br>**8 lecture hours** |
| Site selection, various types of bridges, loads on bridges according to IRC codes, Design of RC bridges under concentrated loads using effective width method. |
| **Unit II: Deck slab of T-Beam Bridges**<br><br>**8 lecture hours** |
| Pigeauds curves, Calculation of bending moments, Design of deck slab for T-beam Bridge for different types of vehicles. |
| **Unit III: Girders of T-Beam Bridge**<br><br>**8 lecture hours** |
| Courbon's method of load distribution, Analysis and design of girders for T-beam Bridge for different types of vehicles, Concept of box culverts |
| **Unit IV: Design of Plate Girders and Steel Trussed Bridges**<br>**8 lecture hours** |
| Design principles, Design and detailing of plate girder bridges, Types of trusses, Design of steel trussed bridges. |
| **Unit V: Design of Substructures**<br><br>**8 lecture hours** |
| Types of piers, Forces acting on piers, Design of piers, General features of abutments, Forces acting on abutments, Design of abutments |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Victor D. J. (2008), Essentials of Bridge Engineering, 6th Edition, Oxford University Press, ISBN: 9788120417175.
2. Ramachandra (2004), Design of Steel structures, 4th Edition, Standard Publishers Distributors, ISBN: 9780071544115.
3. Duggal S. K. (2008), Design of Steel Structures, 3rd Edition, Tata McGraw-Hill, ISBN: 9780070260689.
4. IRC Bridge Codes.

| Name of The Course | Applications of Matrix Methods in Structural Analysis |
|---|---|
| Course Code | BTCE3018 |
| Prerequisite | - |
| Co-requisite | - |

| Anti-requisite | - | | | |
|---|---|---|---|---|
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To understand the basic concepts of flexibility method and stiffness method.
2. To distinguish between force method and displacement method.
3. To understand the behavior of plane trusses & plane frames.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the concept of static and kinematic indeterminacy |
| **CO2** | Understand the concept of flexibility matrix method and stiffness matrix method |
| **CO3** | Analyze plane trusses & plane frames |
| **CO4** | Understand the concept of plate girders, gantry girders and roof trusses. |
| **CO5** | Calculate different types of loadings on roof trusses |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction to Flexibility Matrices and Stiffness Matrices**<br>**8 lecture hours** |
| Flexibility and stiffness matrices- relationship between flexibility and stiffness matrices- properties of stiffness and flexibility matrices - concept of co-ordinates-solution of simple problems. |
| **Unit II: Analysis of Beams by Flexibility Matrix Method**<br><br>**8 lecture hours** |
| Flexibility matrices for beams - solution of statically indeterminate beams–shear force diagram and bending moment diagram. |
| **Unit III: Analysis of Beams by Stiffness Matrix Method**<br><br>**8 lecture hours** |
| Stiffness matrices for beams - solution of kinematically indeterminate beams–shear force diagram and bending moment diagram |
| **Unit IV: Analysis of Plane Truss by Stiffness Matrix Method**<br><br>**8 lecture hours** |
| Stiffness matrices for plane truss - solution of simple problems. |
| **Unit V: Analysis of Plane Frame by Stiffness Matrix Method**<br><br>**8 lecture hours** |
| Stiffness matrices for plane truss - solution of simple problems. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Pundit G.S., & Gupta S.P., (2008), Structural Analysis (A matrix approach), Tata McGraw Hill Publishing Ltd.
2. Amin Ghali, Adam M Neville and Tom G Brown, “Structural Analysis: A Unified Classical and Matrix Approach”. Sixth Edition, 2007, Chapman & Hall.
3. Devdas Menon,"Advanced Structural Analysis" (2009), Narosa Publishing House
4. Devdas Menon, "Structural Analysis" (2008), Narosa Publishing House, 2008

| Name of The Course | Expansive Soil and Ground Improvement Techniques |
|---|---|
| **Course Code** | BTCE3019 |
| **Prerequisite** | - |
| **Co-requisite** | - |
| **Anti-requisite** | - |

| | L | T | P | C |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To find out proper methods of ground improvement.
2. To understand various soil engineering problems.
3. To use geo-textiles and stabilizers for soil improvement.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the physical & mineralogical properties of expansive soil. |
| **CO2** | Conduct tests for identification of swelling soil. |
| **CO3** | Design suitable method for improving properties of expansive soil. |
| **CO4** | Choose correct method for ground improvement. |
| **CO5** | Design grouting process for various soil engineering problems. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Origin, Occurrence and Identification of Expansive Soils** **9 lecture hours** |
| Occurrence and distribution in India - Moisture equilibrium - Soil, structure, environmental interaction - Distress symptoms case histories - Soil Structure - Clay mineralogy Swell potential - Field exploration - laboratory tests for identification. |
| **Unit II: Chemical stabilization and Special Foundation** **9 lecture hours** |
| Mechanical alteration – Sand cushion technique - CNS concept – Chemical stabilization with lime, flyash and cement – Special foundations – Under-reamed piles – Straight-shafted drilled piers - Belled piers – Granular pile-anchors. |
| **Unit III: Introduction to Ground Improvement Techniques** **9 lecture hours** |
| Need and objectives of ground improvement, classification of ground modification techniques, suitability and feasibility, emerging trends in ground improvement, methods of de-watering, sumps and interceptor ditches, single, multi stage well points, vacuum well points, Horizontal wells, foundation drains, blanket drains, criteria for selection of fill material around drains, Electro-osmosis. |
| **Unit IV: Stabilization** **8 lecture hours** |
| Soil improvement by adding materials, lime, flyash, cement and other chemicals and bitumen, sand column, stone column, sand drains, prefabricated drains, lime column, soil-lime column, stabilization of soft clay or silt with lime, bearing capacity and settlement of treated soils, improvement in slope stability, control methods. |
| **Unit V: Grouting** **8 lecture hours** |
| Introduction, suspension grout, solution grout, grouting equipments and methods, grouting, design and layout granular piles – ultimate bearing capacity and settlement, method of construction, load test. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Colin Jfp Jones (1996), Earth Reinforcement & Soil Structures, Thomas Telford. ISBN: 978-07-277-3489-1.
2. Nelson, John D. Nelson, Ron Miller (1997), Expansive Soils: Problems and Practice in

Foundation and Pavement Engineering New edition, Wiley-Interscience. ISBN: 978-04-711-8114-9.

3. P. Purushothama Raj (1999), Ground Improvement Techniques 1st Edition, Laxmi Publications. ISBN: 978-81-318-0594-7.

4. Rao (1990), Engineering with Geo-synthetics, Mcgraw-hill Education. ISBN: 978-00-746-0323-9.

| **Name of The Course** | **Advanced Geotechnical Engineering** | | | |
|---|---|---|---|---|
| **Course Code** | BTCE3020 | | | |
| **Prerequisite** | BTCE3003 | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To understand the design aspects of foundation.
2. To evaluate the stress developed in the soil medium.
3. To understand the framework of soil investigation.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Comprehend and utilize the geotechnical literature to establish the framework for foundation design. |
| **CO2** | Plan and implement a site investigation program including subsurface exploration to evaluate soil/structure behavior and to obtain the necessary design parameters. |
| **CO3** | Carry out slope stability analysis for various fills and slopes. |
| **CO4** | Carry out slope stability analysis for various fills and slopes. |
| **CO5** | Understand theories of earth pressures and designing of retaining walls. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: Soil Exploration and Types of Foundations**<br><br>**7 lecture hours** |
|---|
| Objective of site investigation - reconnaissance – detailed site investigation - methods of exploration – geophysical methods - seismic refraction survey. Depth of exploration – factors governing location and depth of foundation – types of foundations – selection of foundation – plate load test – standard penetration test. |
| **Unit II: Capacity and Settlements of Shallow Foundations**<br><br>**7 lecture hours** |
| Terzaghi's theory of bearing capacity – general and local shear failure - effect of water table – design of footings – settlement of footings - immediate and time dependent settlement – permissible limits – differential settlement, introduction to Codal provisions. |
| **Unit III: Deep Foundations**<br><br>**7 lecture hours** |
| Classification and selection of piles – static and dynamic formulae for single pile capacity – efficiency and capacity of pile groups – design of pile group – settlement of pile groups– load test on piles. |
| **Unit IV: Slope Stability** **9 lecture hours** |
| Failure of infinite and finite slopes – Swedish circle method – Factor of safety - slope stability of earth dams, introduction to Bishop's method – IS codes |
| **Unit V: Theories of Earth Pressure**<br><br>**7 lecture hours** |
| Definitions – Earth pressure at rest – Rankine's active and passive earth pressures - Coulomb's earth pressure theories – types of retaining walls and its design. Introduction of tunneling, ground improvement methods – compaction, deep compaction and fiber reinforced plastic and geo-textiles. |

| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
|---|
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Shashi K. Gulhati&Manoj Datta (2005), Geotechnical Engineering 1st edition, Tata McGraw Hill Ltd. ISBN: 978-00-705-8829-5.
2. Donald P Coduto, William A. Kitch, Man-chu Ronald Yeung (2010), Geotechnical Engineering: Principles and Practices 2nd revised Edition, Pearson Education. ISBN: 978-01-313-5425-8.
3. Joseph E. Bowles (2006), Foundation Analysis and Design 5th edition, McGraw-Hill, New York. ISBN: 978-00-711-8844-9.
4. Braja M. Das (2007), Principles of Foundation Engineering 6th Edition, Nelson Engineering. ISBN: 978-81-315-0202-0.

| **Name of The Course** | **Highway Pavement Design** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BTCE3021** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 3 | 0 | 0 | 3 | |

**Course Objectives**

1. To introduce various analysis and design procedures of different types of pavements.
2. To familiarise with maintenance, evaluation, strengthening and rehabilitation of the pavements.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Learn the basic principles of flexible and rigid pavements. |
| **CO2** | Demonstrate the ability to analyse and design the flexible and rigid pavements by applying various methods and thorough in construction procedures and the functions of pavements |
| **CO3** | Ability to critically evaluate flexible and rigid pavements by deflection measurement. |
| **CO4** | Demonstrate the ability to apply strengthening techniques and rehabilitation of pavements. |
| **CO5** | Know about maintenance of bituminous surface concrete roads. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: General Principles of Pavement Design** **7 lecture hours** |
|---|
| Components of a road and functions – factors affecting pavements stability – equivalent single wheel load – vehicle and traffic factors – moisture factors – climate factors – soil factors – stress distribution in different conditions – modulus of elasticity of various layers. |
| **Unit II: Flexible Pavement Design** **7 lecture hours** |
| Empirical method using soil classification tests – estimation of CBR value method of designing pavement – plate bearing test method Ashpalt Institute method – AASSO method – Burmister design method. |
| **Unit III: Rigid Pavement Design** **7 lecture hours** |
| Stresses in concrete pavement – IRC method – design of steel reinforcements – design of different joints in concrete pavements and their functions – construction of concrete pavements and their functions. |
| **Unit IV: Pavement Evaluation** **7 lecture hours** |

| |
|---|
| Distresses in flexible pavements – distress in rigid pavements – service ability index – structural evaluation of flexible and rigid pavements – evaluation by deflection measurement – strengthening of pavements – flexible overlays – rigid overlays. |
| **Unit V: Highway Maintenance** **10 lecture hours** |
| Maintenance of Bituminous surface concrete roads and low cost roads – maintenance shoulders and drainage system – maintenance of bridges and road structures. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**


1. ChakroborthyPartha, and Das Animesh, (2003) "Principles of Transportation Engineering", Eighth Printing, Prentice-Hall of India, ISBN-9788120320840.
2. Yoder.E.J., and Witczak. M. W., Principles of Pavement Design, Second Edition, John Wiley & Sons, ISBN-9780471977803.
3. Garber. Nicholas J., and Hoel. Lester A., (2009), Traffic & Highway Engineering, Fourth Edition, Cengage Learning, ISBN-9780495082507.
4. S.K. Sharma (1998), Principles, Practice and Design of Highway Engineering, S. Chand & Co Ltd, New Delhi.
5. Bruce.A.G. and Clarkeson.J., (1952), Highway Design and Construction, Third Edition, International Textbook Co.


| **Name of The Course** | **Traffic Engineering** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3022** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To teach the concepts of traffic studies, traffic facilities and their regulations and management.
2. To understand the methods for efficient management of traffic in urban roads.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Perform traffic studies. |
| **CO2** | Know importance of traffic management. |
| **CO3** | Identify the specification of traffic facilities. |
| **CO4** | Understand disinfection processes in water treatment. |
| **CO5** | Discuss on Latest Research Paper. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Traffic Studies** **7 lecture hours** |
| Road user and Vehicle Characteristics - Traffic Studies -Traffic volume and composition - speed, Headway - Concentration and Delay & Flow principles - Capacity and level of service. |
| **Unit II: Traffic Facilities** **7 lecture hours** |
| Signals - Islands - Types and General layout of at-grade and grade separated intersections. |
| **Unit III: Traffic Regulations and Management** **7 lecture hours** |
| Traffic signs and markings - Parking practices - Traffic management measures. |
| **Unit IV: General Principles and Flexible Pavement Design** **7 lecture hours** |
| Factors affecting pavements stability – equivalent single wheel load – vehicle, soil, traffic & |

| |
|---|
| Climatic factors - stress distribution in different conditions - CBR method of design - AASSO method & Burmister design method. |
| **Unit V: Rigid Pavement Design** **10 lecture hours** |
| Stresses in concrete pavement – IRC method – design of steel reinforcements – Function of joints, design of joints in concrete pavements - Joint Fillers and sealant. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Kadiyali.L.R. (2008), Traffic Engineering and Transportation Planning, Khanna Publishers, ISBN-9788174092205.

2. ChakroborthyPartha, and Das Animesh, (2003), Principles of Transportation Engineering, Eighth Printing, Prentice-Hall of India, ISBN-9788120320840.

3. Khisty.C.J., and Lall.B.K., (2003) "Transportation Engineering", Indian Edition, Prentice-Hall of India , ISBN- 9788120322127.

4. Garber. Nicholas J., and Hoel. Lester A., (2009), Traffic & Highway Engineering, Fourth Edition, Cengage Learning, ISBN-9780495082507.

| **Name of The Course** | **Ground Water Engineering** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3024** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To enable the students to educate on ground water movement analysis & predictions.
2. To make the students to understand the concept to increase ground water potential.
3. To enable the students to identify the sources of the ground water.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand hydrologic cycle. |
| **CO2** | Explain geophysical methods. |
| **CO3** | Analyze and evaluate pumping level. |
| **CO4** | Monitor pollution of groundwater. |
| **CO5** | Calculate groundwater storage capacity and groundwater potential. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Occurrence and Movement of Groundwater** **10 lecture hours** |
| Introduction to Hydrologic cycle – Origin and Age of groundwater, classification of groundwater, aquifer - water table - Darcy's Law, Coefficient of Transmissibility and storage - Flow rates and equation. |
| **Unit II: Well Hydraulics** **9 lecture hours** |
| Geophysical methods, study of radial flow - well flow, Multiple well system - characteristic well losses, open well, tube well, well depth, well screen - head losses through the screen gravel packing and formation stabilization. |
| **Unit III: Analysis and Evaluation of Pumping Test** **9 lecture hours** |
| Definition of terms - static water level, pumping level, drawdown – residual, drawdown pumping rate -automatic water level recorder - time drawdown analysis - distance drawdown analysis, Jacob's methods, pumping test methods. |
| **Unit IV: Pollution of Groundwater** |

| |
|---|
| **8 lecture hours** |
| Injection methods-monitoring: - Cement lime, Lime – fly ash and chemical stabilization, Deep mixing techniques. |
| **Unit V: Groundwater Assessment and Budgeting** **9 lecture hours** |
| Hydrological equilibrium - rain gauge network, runoff procedure for conducting infiltration test – artificial recharge, rainwater harvesting – calculation of groundwater storage capacity and groundwater potential. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. David Keith Todd (2005), Groundwater Hydrology, Third Edition, John Wiley & Sons Singapore. ISBN: 9780471059370.
2. Raghunath H.M. (2007), Groundwater, Third Edition, New Age International. ISBN: 9788122419047.
3. Abdel-Aziz ismailkashef (2008), Groundwater Engineering, McGraw-Hill International Editions, Newyork. ISBN: 9780071005333.

| **Name of The Course** | **Advanced Hydrology** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BTCE3025** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 3 | 0 | 0 | 3 | |

**Course Objectives**

1. To enable the students to understand the planning and construction of irrigation structures.
2. To make the students to understand the measures of flood control and economic functioning of hydrologic structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand details of hydrograph. |
| **CO2** | Explain ground water hydrology. |
| **CO3** | Know the causes and effects of water logging. |
| **CO4** | Understand the functions of dams and reservoirs. |
| **CO5** | Carry out flood analysis. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Hydrograph** **9 lecture hours** |
| Runoff - Factors affecting runoff – measurement – stream gauging – stage discharge relationship – Hydrograph components |
| **Unit II: Ground Water Hydrology** **9 lecture hours** |
| Ground water-Aquifers, Permeability & transmissibility- steady flow towards a well in confined & water table aquifer - Dupits & Theims equation - measurement of yield of an open well - Tube well & infiltration galleries. Interference among wells-well losses, comparison of well and flow irrigation. |
| **Unit III: Canal Irrigation** **9 lecture hours** |
| Sediment Transport- Importance & Mechanics of transport, bed load & suspended load- Estimation, Design of channels in India- Regime channels-Kennedy and Lacey's theory, Water logging-causes- effects- control measures, canal lining, Land Reclamation. |
| **Unit IV: Dams and Reservoirs** **9 lecture hours** |
| Classification of dams - factors governing their selection – elementary design of gravity dam – earthen dam – arch dam – spillways – energy |

| |
|---|
| depositors – spillway gates – important dams in India – Yield of reservoir – storage capacity – strategies and operation – sedimentation process – effects and control measures. |
| **Unit V: Flood Analysis** **9 lecture hours** |
| Empirical methods – statistical methods – flood routing – routing through reservoir routing – through channels (Muskinggum method) – flood forecasting. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

**1.** Subramanya K. (2008), Engineering Hydrology, Tata McGraw Hill Co., Graw Hill Co. ISBN: 9780074624494**.**

2. Varshney R.S. (2012), Engineering Hydrology, Nem Chand & Brothers Publishers. ISBN: 8185240688.

3.Das (2009), Hydrology & Soil Conservation Engineering, Prentice-Hall of India. ISBN: 9788120335868.

| **Name of The Course** | **Pollution Control and Monitoring** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3026** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To understand the factors that must be satisfied for potable water, land and air for the removal and treatment of pollutants.
2. To provide a strong link between the Pollution Damage, Public Authority Control Systems and Technical Control Systems
3. To know the relationship between social, legislative and biological constraints in a modern developed society.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Describe the principles of the biological and chemical treatment processes that are required to ensure adequate quality and quantities of potable water. |
| **CO2** | Implement the principal techniques currently in use for wastewater treatment and to review operational procedures for the plant involved. |
| **CO3** | Use advanced methods for monitoring and modeling spatial and temporal patterns of pollution. |
| **CO4** | Know solid waste management |
| **CO5** | Understand disinfection processes in water treatment. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Water Pollution & Control** **7 lecture hours** |
| Natural process-pollution due to industrial, agricultural and municipal wastes-limitations of disposal by dilution-BOD consideration in streams – Oxygen Sag Curve-Water pollution control legislation. |
| **Unit II: Air Pollution and Control** **7 lecture hours** |
| Pollution and their sources-effects of pollution on human health, vegetation and climate-prevention and control of particulate-industry and air-pollution surveys and sampling-Air quality monitoring- air pollution control legislation. |

| **Unit III: Noise Pollution and Control**<br><br>**7 lecture hours** |
|---|
| Sound and Noise: Sources of noise pollution – environmental and industrial noise; effects of noise pollution; fundamentals of sound generation, propagation etc; sound measurement; sound level meters – types, components, Measures for prevention and control of noise; environmental and industrial noise; noise control legislation. |
| **Unit IV: Solid Waste Management**<br>**8 lecture hours** |
| Source characteristics – quantities – collection methods and disposal techniques – sanitary landfill – incineration – and pyrolysis, composting, aerobic and anaerobic- economics of composting; recycling and reuse. |
| **Unit V: Environmental Sanitation**<br><br>**7 lecture hours** |
| Relation of food to disease-principles of food sanitation-sanitation of kitchens, restaurants and other catering establishments-quality changes in milk-milk as carrier of infection-pasteurization of milk-HTST and LTLT processes – cattle shed sanitation. Orientation of buildings with respect to the direction of prevailing winds and solar movement. Air movement inside the buildings for a healthy residential environment. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Rao C.S. (2006), Environmental Pollution Control Engineering, New Age International, ISBN: 9788122418354.
2. Arcadio P Sincero, Gregoria A Sincero (2009), Environmental Engineering : A Design Approach, PHI Learning, ISBN: 9788120314740.
3. George Tchobanoglous, Donald R. Rowe, Howard S. Peavy, Environmental Engineering, McGraw-Hill Publishing Co., ISBN: 9780071002318.
4. P. AarneVesilind, Susan M. Morga (2004), Introducing to Environmental Engineering, Nelson Engineering, ISBN: 9780534378127.

| **Name of The Course** | **Industrial Waste Treatment and Disposal** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3027** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. Get the adequate knowledge about phenomena of atmospheric environment and treatment, sources, characteristics and treatment processes of various types of industries.
2. Know the various processes of wastewater treatment of different industries and the engineering requirements for treatment facilities.
3. Design the waste treatment system for the different industry

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Provide solutions of physical, chemical and biological treatment and biosensors applied to biological process control |
| **CO2** | Use new techniques for collection, recycling and disposal and treatment of wastewater and solid wastes. |
| **CO3** | Design the wastewater supply and treatment technology |
| **CO4** | Evaluate and monitor the treatment systems according to the need of different industries |
| **CO5** | Calculate different types of loadings on roof trusses |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Industrial Pollution**<br><br>**8 lecture hours** |
| Types of industries and industrial pollution – Characteristics of industrial wastes – Population equivalent – Bioassay studies – effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health – Hazardous Wastes – Environmental legislations related to prevention and control of industrial effluents and hazardous wastes – Pollution Control Boards |
| **Unit II: Waste Management Approach**<br><br>**8 lecture hours** |
| Waste management approach – Waste Audit – Volume and strength reduction – material and process modifications – Recycle, reuse and byproduct recovery – Applications. |
| **Unit III: Liquid Waste Treatment Techniques**<br><br>**8 lecture hours** |
| Equalization – Neutralization – removal of suspended and dissolved organic solids - Chemical oxidation – Removal of dissolved inorganics – Combined treatment of industrial and municipal wastes – Residue management. |
| **Unit IV: Industrial Solid Waste Treatment**<br><br>**8 lecture hours** |
| Physico-chemical treatment – solidification – incineration – Secured landfills – Legal Provisions. |
| **Unit V: Case Studies of Industrial Pollution Control**<br>**8 lecture hours** |
| Sources & their Characteristics, waste treatment flow sheets for selected industries such as textiles, tanneries, dairy, sugar, paper, distilleries, steel plants, refineries, fertilizer, and thermal power plants |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Patwardhan A.D. (2008), Industrial Waste Water Treatment, PHI Learning Pvt Ltd. ISBN: 978-81-203-3350-5
2. Nelson, L. Nemerow (2007), Industrial Waste Treatment: contemporary practice and vision for future, Elsevier Butterworth-Heinemann Publication. ISBN: 9780123724939
3. Woodard & Curran Inc. (2006), Industrial Waste Treatment Handbook, Second Edition, Elsevier Butterworth-Heinemann Publication. ISBN: 9780750679633
4. Thomas T. Shen (1999), Industrial Pollution Prevention, Springer publications. ISBN: 3540652086
5. W .W. Eckenfelder Jr. (2000), "Industrial Water Pollution Control", McGraw-Hill Book Company, New Delhi. ISBN: 9780070393646

| **Name of The Course** | **Air and Noise Pollution** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE3028** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To understand the aspects of atmospheric pollution and its flow.
2. To know about the issues such as atmospheric composition, monitoring, acidic deposition, urban air quality
3. To understand the use and application of air quality models for the identification of plume flow.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | The main chemical components and reactions occur in the atmosphere and examine the factors responsible for perturbing this. |

| | |
|---|---|
| **CO2** | Implement the methods for monitoring and modeling spatial and temporal patterns of pollution. |
| **CO3** | The Implementation of the methods for monitoring and modeling spatial and temporal patterns of pollution. |
| **CO4** | The air pollution issues at a range spatial scales and how these are relaxed. |
| **CO5** | The environmental impacts of atmospheric pollutants and assess their concentration. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Sources and Effects of Air Pollution**<br><br>**7 lecture hours** |
| Classification of air pollutants – Particulates and gaseous pollutants – Sources of air pollution – Source inventory – Effects of air pollution on human beings, materials, vegetation, animals – global warming-ozone layer depletion, Sampling and Analysis – Basic Principles of Sampling – Source and ambient sampling – Analysis of pollutants – Principles. |
| **Unit II: Transport of Air Pollution**<br>**9 lecture hours** |
| Elements of atmosphere and dispersion of pollutants – Meteorological factors – Wind roses – Lapse rate - Atmospheric stability and turbulence – Plume rise – Dispersion of pollutions – Gaussian dispersion models – Applications. |
| **Unit III: Control of Air Pollution**<br><br>**7 lecture hours** |
| Concepts of control – Principles and design of control measures – Particulates control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation – Selection criteria for equipment, gaseous pollutant control by adsorption & absorption, condensation, combustion – Pollution control for specific major industries. |
| **Unit IV: Air Quality Management**<br><br>**7 lecture hours** |
| Air quality standards – Air quality monitoring – Air pollution control efforts – Zoning – Town planning regulation of new industries – Legislation and enforcement – Environmental Impact Assessment – Methods. |
| **Unit V: Noise Pollution & Control**<br><br>**7 lecture hours** |
| Sound and Noise: Sources of noise pollution – environmental and industrial noise; effects of noise pollution- fundamentals of sound generation - propagation, sound measurement - sound level meters – types, components, Noise prevention & control measures, environmental and industrial noise - noise control legislation. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. M N Rao& H V N Rao (2007), Air Pollution, Tata McGraw-Hill Publishing Company, 26th reprint, New Delhi. ISBN: 0074518718
2. Noel De Nevers (2010), Air Pollution Control Engineering, 2nd Edition, Waveland Press, Inc., Long Grove, Illinois. ISBN: 978-1577666745
3. Singal, S.P. (2000), Noise Pollution and Control, First Edition, Narosa Publishing House, New Delhi.ISBN: 8173193630
4. Rao C.S. (2006) Environmental Pollution Control Engineering, 2nd edition, New Age International,New Delhi. ISBN: 9788122418354

| | |
|---|---|
| **Name of The Course** | **Pre-Stressed Concrete Structures** |
| **Course Code** | BTCE4007 |
| **Prerequisite** | - |
| **Co-requisite** | - |
| **Anti-requisite** | - |

| | L | T | P | C |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To analyze sections for flexure and deflection.
2. To analyse the Losses of pre stressed members.
3. To analyse the Transfer of Prestress in Pre tensioned Members and Anchorage Zone Stresses in Post Tensioned Members

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Analyze sections for flexure and deflection |
| **CO2** | Analyze the Losses of pre stressed members |
| **CO3** | Analyze the Transfer of Prestress in Pre tensioned Members and Anchorage Zone Stresses in Post Tensioned Members. |
| **CO4** | Visualize and work on multi-disciplinary tasks |
| **CO5** | Use modern engineering tools, software and equipment to analyze and design. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Basic Principles of Pre-Stressing, Prestressing Systems**<br>**8 lecture hours** |
| Basic concepts of prestressing, High strength concrete and steel, Stress-strain characteristics and properties, Various prestressing systems, Pre-tensioning and Post- tensioning systems with anchorages, Advantages and limitations of prestressed concrete. |
| **Unit II: Analysis of Sections for Flexure**<br>**8 lecture hours** |
| Basic assumptions, Analysis of stresses in concrete due to pre- stress and loads for different types of cross section, Pressure line or thrust line, Cable profile, Concept of load balancing, Cracking moment. |
| **Unit III: Losses of Pre-Stress & Deflections**<br>**8 lecture hours** |
| Nature of losses in pre-stress, Various losses encountered in pre-tensioning and post tensioning methods, Deflection, Factors influencing deflection, Elastic deflection under transfer loads and due to different cable profile. Deflections limits as per IS-1343, Effects of creep on deflection, crack widths |
| **Unit IV: Flexural and Shear Strength of Prestressed Concrete Sections**<br>**8 lecture hours** |
| Types of flexural failure, IS code recommendations for flexure, Ultimate flexural strength of section. Shear and principal stresses, Ultimate shear resistance of prestressed concrete members, Shear reinforcement |
| **Unit V: Transfer of Prestress in Pre tensioned Members and Anchorage Zone Stresses in Post Tensioned Members**<br>**8 lecture hours** |
| Transmission of pre-stress in pre-tensioned members, Transmission length, Bond stresses, Codal provisions for bond and transmission length, Anchorage stress in post- tensioned member. Bearing stress and bursting tensile force, IS code provisions. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Raju, N. K., "Pre-stressed concrete", Tata McGraw Hill, New Delhi, 1st Edition, 2012.
2. Ramamruthum, S., "Pre-stressed Concrete", Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2003.

3. Lin, T. Y., Burns, N. H., "Design of pre- stressed Concrete Structures", John Wiley and Sons. New York, 3rd Edition, 1981

| Name of The Course | Dynamics of Structures and Earthquake Engineering | | | |
|---|---|---|---|---|
| Course Code | BTCE4008 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To enable students to analyze structures subjected to dynamic loading.
2. To make the students to design structures for seismic loading as per code provisions.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand SDOF system and MDOF system. |
| **CO2** | Analyse structures subjected to dynamic loading. |
| **CO3** | Design structures for seismic loading as per code provisions. |
| **CO4** | Understand about the elements of seismology. |
| **CO5** | Design earthquake resistant masonry buildings. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Theory of Vibrations** **9 lecture hours** |
| Difference between static loading and dynamic loading – Degree of freedom – idealisation of structure as single degree of freedom system – Formulation of Equations of motion of SDOF system – D'Alemberts principles – effect of damping – free and forced vibration of damped and undamped structures – Response to harmonic and periodic forces. |
| **Unit II: Multiple Degree of Freedom System** **9 lecture hours** |
| Multi Degree of freedom system – modes of vibrations – formulation of equations of motion of multi degree of freedom (MDOF) system – Eigen values and Eigen vectors – Response to free and forced vibrations – damped and undamped MDOF system – Modal superposition methods. |
| **Unit III: Elements of Seismology** **9 lecture hours** |
| Elements of Engineering Seismology – Causes of Earthquake – Plate Tectonic theory – Elastic rebound Theory – Characteristic of earthquake – Estimation of earthquake parameters – Magnitude and intensity of earthquakes – Spectral Acceleration. |
| **Unit IV: Response of Structures to Earthquake** **9 lecture hours** |
| Effect of earthquake on different type of structures – Behaviour of Reinforced Cement Concrete, Steel and Prestressed Concrete Structure under earthquake loading – Pinching effect –Bouchinger Effects – Evaluation of earthquake forces as per IS:1893 – 2002 – Response Spectra – Lessons learnt from past earthquakes. |
| **Unit V: Design Methodology** **9 lecture hours** |
| Causes of damage – Planning considerations / Architectural concepts as per IS:4326 – 1993 – Guidelines for Earthquake resistant design – Earthquake resistant design for masonry and Reinforced Cement Concrete buildings – Later load analysis – Design and detailing as per IS:13920 – 1993. |
| **Unit VI: Discussion on Latest Research Paper** **4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Chopra, A.K., "Dynamics of Structures – Theory and Applications to Earthquake Engineering", 4th Edition, Pearson Education, 2011.
2. Agarwal. P and Shrikhande. M., "Earthquake Resistant Design of Structures", Prentice Hall of India Pvt. Ltd. 2007
3. J. Humar, (2012), Dynamics of Structures, Third Edition, CRC Press, *ISBN-13:* 9780415620864.
4. Anil K. Chopra, (2003), Dynamics of Structures - Theory and Applications to Earthquake Engineering, Third Edition, Pearson India, ISBN-13: 9788131713297.
5. Biggs, J.M., "Introduction to Structural Dynamics", McGraw Hill Book Co., New York, 1964
6. Dowrick, D.J., "Earthquake Resistant Design", John Wiley & Sons, London, 2009

| **Name of The Course** | **Open Channel Hydraulics** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **BTCE4009** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | 3 | 0 | 0 | 3 | |

**Course Objectives**

1. To provide knowledge about various types of flows and properties in open channels.
2. To provide knowledge in detail about gradually varied flow, rapidly varied flow and spatially varied flow.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the various types of flows in open channels |
| **CO2** | Determine velocity distribution across and along the channel, and hydraulic jumps. |
| **CO3** | Design the channel sections, drains, and jumps for various hydraulic and hydrologic projects. |
| **CO4** | Understand the concept of plate girders, gantry girders and roof trusses. |
| **CO5** | Calculate different types of loadings on roof trusses |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: Introduction** **8 lecture hours** |
|---|
| Introduction, Pipe Flow and Free Surface Flow, Continuity Equation, Energy in Free Surface Flow, Basic Momentum Equation, Velocity Distribution, Velocity Measurement and Distribution, Velocity-area Method, Radio-active tracer technique for Measurement of River Discharges, Errors in Depth Measurement in High Velocity Flows, Secondary Current and Spiral Flow, Energy and Momentum Coefficients-Derivation and Coefficients for Different Velocity Distributions, Comparison between Momentum and Energy Equation, Pressure Distribution, Specific Energy Equations for Rectangular Channels, Application of Specific Energy, Specific Force. |
| **Unit II: Critical Flow** **8 lecture hours** |
| Characteristics of Critical Flow, Occurrence, Critical Depth in Trapezoidal & Circular Channels, Hydraulic Exponent for Critical Flow, Critical Flow Depth Computations, Flow Measurement, Measuring Flumes, Critical Depth Flumes, Weirs-Introduction, Types of Control Structures, Proportional weirs, Flow Over weirs, Polygonal weirs, Special types of weirs, Broad Crested weirs, Different types of Broad Crested weirs, Bear Trap weir, Flow below a Sluice Gate, Brink Depth, Modern Measurements of Flow Measurements, Outlets & Modules, Errors in Measurements, International Standards for Flow Measurement in Open Channel. |
| **Unit III: Uniform Flow** **8 lecture hours** |
| Concept of Uniform Flow, Derivation of Uniform Flow Equations, Resistance in Open Channel Hydraulics, History of Uniform Flow Velocity |

| |
|---|
| and Resistance Factor, Friction, Ganguillet and Kutter Formula, Conveyance, Section Factor for Uniform Flow Computation, Hydraulic Exponent for Uniform Flow Computation, Maximum Discharge, Classification of bed Slope, Solution of Manning Equation by Newton Raphson Method, Slope-area Method, Normal & Critical Slopes, Design of Canals, Typical Canal Cross Sections, Lining the Canal, Seepage Prevention with Impermeable membranes, Failure of Canal Lining, Most Efficient Hydraulic Section, Design of Unlined Channels |
| **Unit IV: Gradually Varied Flow**<br>**8 lecture hours** |
| Introduction, Dynamic Equation for Steady Gradually Varied Flow, Classification of Gradually Varied Flow Profiles, Real Life Cases of Water Surface Profiles, Sketching of Composite Water Surface Profiles, Computation of Gradually Varied Flow, Integration of Differential Equation, Improved Euler Method, Fourth-order Runga-Kutta Method |
| **Unit V: Hydraulic jump**<br>**8 lecture hours** |
| Normal Hydraulic Jumps, Classification of Jumps, Momentum Equation, General Hydraulic Jump Equation, Energy loss in the Jump, Turbulent Characteristics of the Jump, Pressure Distribution in the Jump, Velocity Distribution in Hydraulic Jump, Length of the Jump, Air Entrainment Characteristics of the Jump, Pre Entrained Hydraulic Jump, Air Concentration Distribution along the Jump, Decay of Turbulence Downstream from a Stilling Basin, Hydraulic Jumps in Sloping Channels, Stilling Basin, Baffle Stilling Basin, Bhavani Type Stilling Basin, Stilling Basin in Sudden Expansion, Slotted Bucket Stilling Basin. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Subramanya, K., (2008) Flow in Open Channels, 3rd ed., Tata McGraw-Hill. ISBN - 9780070699663
2. V. T .Chow (2009), Open Channel Hydraulics, Blackburn Press. 9781932846188.
3. Asawa, G. L., (2010), Fluid Flow in Pipes and Channels, CBS Publishers. ISBN - 9788123917238
4. Chanson, H., (2004), The Hydraulics of Open Channel Flow: An Introduction, Elsevier Scientific. ISBN- 9780750659789

| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Water Resources System Engineering** | | | |
| **Course Code** | **BTCE4010** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To provide information about need of water resources engineering in India and teach basic concepts of surface and ground water hydrology and irrigation aspects.
2. To teach various optimization techniques.
3. To provide information about water resources engineering structures**.**

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the components of planning and management in water resources |
| **CO2** | Use various optimization methods |
| **CO3** | Use linear and dynamic programming of water resource problems. |
| **CO4** | Understand the concept of plate girders, gantry girders and roof trusses. |
| **CO5** | Calculate different types of loadings on roof trusses |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction and Basic Concepts**<br><br>**8 lecture hours** |
| Introduction, System Components, Planning and management, Concept of a system, Advantages and limitations of systems approach, Modelling of Water Resources Systems, Simulation and optimization, Economics in water resources, Challenges in water sector. |
| **Unit II: Introduction to Optimization**<br><br>**8 lecture hours** |
| Objective function, Maxima, minima and saddle points, convex and concave functions, Constrained and unconstrained optimization using calculus, Lagrange multipliers, Kuhn-Tucker conditions. |
| **Unit III: Linear & Dynamic Programming and Applications**<br>**8 lecture hours** |
| General form of LP, Standard and Canonical forms of LP, Elementary transformations, Graphical method, Feasible and infeasible solutions, Simplex method, Dual and sensitivity analysis, LP problem formulation, Reservoir sizing and Reservoir operation using LP, Introduction, multistage decision problem, Recursive Equations, Principle of optimality, Discrete DP, Curse of Dimensionality, Water allocation problem. |
| **Unit IV: Multi-objective & Stochastic Optimization**<br>**8 lecture hours** |
| Position, Velocity and Acceleration – Rectilinear motion – Curvilinear motion of a particle – Tangential and Normal components – Radial and Transverse components – Rotation of rigid bodies about a fixed axis – General plane motion – Absolute and relative motion method – Instantaneous centre of rotation in plane motion - Linear momentum – Equation of motion – Angular momentum of a particle and rigid body in plane motion – D'Alembert's principle |
| **Unit V: Simulation**<br><br>**8 lecture hours** |
| Principle of work and energy for a particle and a rigid body in plane motion – Conservation of energy - Principle of impulse and momentum for a particle and a rigid bodies in plane motion – Conservation of momentum – System of rigid bodies – Impact - direct and central impact – coefficient of restitution |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Jain S.K. and Singh V.P., (2003) 'Water Resources Systems Planning and Management', Elsevier, The Netherlands. ISBN – 9780444514295.
2. Hamdy A. Taha(2006). Operations Research: An Introduction, Prentice Hall, ISBN- 9780131889231.
3. Loucks D.P, Stedinger J.R and Haith D.A, (1981) 'Water Resources Systems Planning and Analysis', Prentice Hall, USA, 1981. ISBN – 9780139459238.
4. Mays L.W and Tung Y-K, (2002) 'Hydrosystems Engineering and Management', Water Resources Pubns, 1992. ISBN – 9781887201322.

| **Name of The Course** | **Transport Planning and Management** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE4011** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To teach the transportation planning process, trip generation and distribution methods.
2. To teach various techniques involved in traffic assignments, and introduce evaluation techniques based on economy and performance.

**.Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Identify the different planning process involved in transportation and the importance of Zoning. |
| **CO2** | Demonstrate the ability to understand the various distribution methods, trip generation and critically apply the analysis techniques practically. |
| **CO3** | Understand the principles in traffic assignment and apply them suitably as a successful transportation Engineer. |
| **CO4** | Demonstrate the ability to evaluate a transport projects critically in all aspects and apply transport planning process effectively for medium and small sized towns. |
| **CO5** | Calculate different types of loadings on roof trusses. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Transport Planning Process**<br><br>**8 lecture hours** |
| Scope – interdependence of land use and traffic – systems approach to transport planning – survey of existing conditions and forecasting future conditions. Transport survey – definition of study area – zoning survey – types and methods – inventory on transport facilities – inventory of land use and economic activities. |
| **Unit II: Trip Generation**<br>**6 lecture hours** |
| Factors governing trip generation and attraction rates – multiple linear regression analysis – category analysis – critical appraisal of techniques |
| **Unit III: Trip Distribution Methods**<br>**9 lecture hours** |
| Uniform factor method, average factor methods – gravity model and its calibration – opportunity model. |
| **Unit IV: Modal Split and Trip Assignment**<br><br>**8 lecture hours** |
| Modal split – factors, advantages and limitations, logit model and its calibration, Traffic assignment – general principles – assignment techniques – all nothing assignment – multiple root assignment – capacity – restraint assignment – diversion curves |
| **Unit V: Evaluation Techniques**<br><br>**8 lecture hours** |
| Economic evaluation techniques – performance evaluation – rating and ranking methods – case studies in evaluation – rating and ranking methods – case studies in evaluation of transport projects – land use transport models – transport planning for medium and small sized towns. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Kadiyali.L.R. (2008), Traffic Engineering and Transportation Planning, Khanna Publishers, ISBN-9788174092205.

2. Ortuzar.J.D., and Willumsen. Luis G. (2011), Modelling Transport, Fourth Edition, John Wiley & Sons, ISBN-9781119993520.

3. Wright.P.H.,Ashford.N., and Stammer.R., (1998), Transportation Engineering – Planning & Design, Fourth Edition, John Wiley & Sons, New York, ISBN-9780471173960.

4. Dickey.J.W., (1995), Metropolitan Transportation Planning, Tata McGraw-Hill publishing company Ltd, New Delhi

| **Name of The Course** | **Disaster Management** | | | |
|---|---|---|---|---|
| **Course Code** | **BTCE4012** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |

| | | | | |
|---|---|---|---|---|
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To know about the types of natural and environmental disasters.
2. To develop skills in various stages of disaster preparedness, mitigation and management.
3. To know the methodology for disaster risk assessment.

**.Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the types of natural and environmental disasters and its causes. |
| **CO2** | Know about organizational and Administrative strategies for managing disasters. |
| **CO3** | Explain the engineering and non-engineering controls of mitigating various natural disasters. |
| **CO4** | About the early warning systems, monitoring of disasters effect and necessity of rehabilitation |
| **CO5** | Learn methodologies for disaster risk assessment with the help of latest tools like GPS, GIS, Remote sensing, information technologies, etc. |
| **CO6** | Discussion on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Natural and Man Made Disasters – Overview**<br>**8 lecture hours** |
| Introduction- Natural Disasters around the world- Natural Disaster Risk Assessment- Earth and its characteristics – Environmental Change and Degradation - Climate Change - Global warming – Human Dimensions of Global environment Change – Disaster mitigation, preparedness, response and recovery- comprehensive emergency management Early warning systems and Disaster Preparedness– Rehabilitation, Vulnerable Populations - Logistics and Services, Food, Nutrition and Shelter -Role of UN Red cross and NGOs, Understanding Man-Made Disasters, Nuclear Disasters, Chemical Disasters, Biological Disasters, Building Fire, Coal Fire, Forest Fire, Oil Fire, Air &Water Pollution, Industrial Pollution, accidents, toxic gas leakages and occupational hazards, exposure to manual and codes issued by NDMA, BIS etc for adopting disaster proof designs related to civil infrastructure development like Housing, dams, highways, airports, industrial complexes etc. |
| **Unit II: Plate Tectonics& Earthquakes**<br>**8 lecture hours** |
| Introduction and Review - Natural Disasters - Principles, Elements, and Systems - Geological- Geo-morphological aspects, - Earthquake- Geology, Seismology, Characteristics and dimensions– Landslides- Human impact on the mountainous terrain and its relationship with Rainfall, liquefaction etc- Tsunami - Nature and characteristics. |
| **Unit III: Critical climate system aspects and Processes**<br>**8 lecture hours** |
| Oceanic, Atmospheric and Hydrologic cycles - Severe Weather & Tornadoes , Cyclones, Floods and Droughts - Global Patterns - - Mitigation & Preparation – Drought – Famine- nature & dimensions – Drought Assessment & Monitoring |
| **Unit IV: Natural hazards Assessment and Communication**<br>**8 lecture hours** |
| Mapping - Modeling, risk analysis and loss estimation – Natural disaster risk analysis - prevention and mitigation - Applications of Space Technology (Satellite Communications, GPS, GIS and Remote Sensing and Information / Communication Technologies (ICT) in Early warning Systems - Disaster Monitoring and Support Centre– Information Dissemination – Mobile Communications etc. |
| **Unit V: Administrative mechanisms**<br>**8 lecture hours** |
| Roles and responsibilities NDMA/SDMA,Social organizations – Education and Training – Establishment of capacity building among various stake holders – Government - Educational institutions – Use of Multi-media knowledge products for self-education. |
| **Unit VI: Discussion on Latest Research Paper**<br>**4 lecture hours** |

This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.

**Suggested Reading**

1. Edward A Keller, Robert H Blodgett (2007), Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes, Pearson Prentice Hall, 2nd Edition. ISBN: 9780132361316
2. Didax (2007), Natural Disasters, Didax Educational Resources: ISBN: 9781583242728
3. Edward Bryant (2005), Natural Hazards, Cambridge University Press, New York. ISBN: 978-0521537438
4. Robert L Kovach Earth's Fury (1995), An Introduction to Natural Hazards and Disasters, Prentice Hall. ISBN: 9780130424334
5. Davi Alexander (1993), Natural Disasters, Routledge. ISBN: 9781857280937

SCHOOL OF CIVIL ENGINEERING

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

# Program: MTech in Energy and Environmental Engineering

**Scheme: 2019-2020**

**Vision**

**To be a Centre of Excellence for imparting high end research and technical education in Civil Engineering producing socially aware professionals to provide sustainable solutions to global community.**

**Mission**

**M1: To impart quality education and mould technically sound, ethically responsible professionals in the field of Civil Engineering.**

**M2: Collaborate with industry and society to design a curriculum based on the changing needs of stakeholders and provide excellence in delivery and assessment.**

**M3: Establish state-of-the-art facilities for world class education and research.**

**M4: To mentor students in pursuit of higher education, entrepreneurship and global professionalism.**

**PEOs**

**PEO1: Graduates shall attain state of the art knowledge in the different streams of Civil Engineering and be trained for playing the role of competent Civil Engineer in multidisciplinary projects.**

**PEO2: Graduates shall be capable of pursuing productive careers in private and government organizations at the national and international level and to become successful entrepreneurs.**

**PEO3: Graduates shall display a high sense of social responsibility and ethical thinking and develop sustainable engineering solutions.**

**PSOs**

**PSO1: Specify, select and formulate environmental engineering systems.**

**PSO2: Analyse environment resources, to design, and evaluate projects in term of environmental impact.**

**POs**

**PO1: Apply the knowledge of Mathematics, Science, and Engineering fundamentals, and an engineering specialization to solution of complex engineering problems (Engineering Knowledge)**

**PO2: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (Problem analysis)**

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

**PO4: Use research based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions (Conduct investigations of complex problems)**

**PO5: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling complex engineering activities with an understanding of limitations (Modern tool usage)**

**PO6: Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice (The engineer and society)**

**PO7: Understand the impact of the professional engineering solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments (Environment and sustainability)**

**PO8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (Ethics)**

**PO9: Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings (Individual and team work)**

**PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large such as being able to comprehend and write effective reports and design documentation, make effective oral presentations, and give and receive clear instructions (Communication)**

**PO11: Demonstrate knowledge and understanding of engineering management principles and apply those to one's own work as a member and leader of a team to manage projects in multidisciplinary environments (Project management and finance)**

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

## Curriculum

| Semester 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sl. No | Course Code | Name of the Course | | | | | Assessment Pattern | | |
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | CENG5001 | Professional and Communication Skills | 0 | 0 | 4 | 2 | 50 | - | 50 |
| 2 | MATH5001 | Advanced Numerical and Statistical Methods | 3 | 1 | 0 | 4 | 20 | 30 | 50 |
| 3 | MENE5001 | Renewable Energy Technology | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | MENE5002 | Physico-Chemical, Biological Principles and Processes | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | MENE5003 | Environmental Quality Monitoring | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | MENE5004 | Energy Auditing, Conservation & Management | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 7 | MENE5005 | Renewable Energy Technology Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 8 | MENE5006 | Environmental Quality Monitoring Lab | 0 | 0 | 4 | 2 | 50 | - | 50 |
| | | Total Credit | | | | 21 | | | |
| **Semester II** | | | | | | | | | |
| Sl No | Course Code | Name of the Course | | | | | Assessment Pattern | | |
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | MENE6001 | Energy, Instrumentation, Measurement & Control | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | MENE6002 | Environmental Audit & Impact Assessment | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | MENE6003 | Design of Water & Wastewater Treatment Systems | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | MENE6004 | Air Pollution & Its Control | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | MENE6019 | Elective-I (Energy Environment Climate Change) | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | MENE6039 | Elective-II (Risk Assessment and Disaster Management) | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 7 | MENE6005 | Seminar | 0 | 0 | 0 | 1 | 50 | - | 50 |
| 8 | MENE6006 | Energy, Instrumentation, Measurement &Control Lab | 0 | 0 | 2 | 1 | 50 | - | 50 |
| | | Total Credit | | | | 20 | | | |
| **Semester III** | | | | | | | | | |
| Sl No | Course Code | Name of the Course | | | | | Assessment Pattern | | |
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | MENE7001 | Comprehensive Examination | 0 | 0 | 0 | 2 | 50 | - | 50 |
| 2 | MENE7002 | Project (Phase I) | 0 | 0 | 0 | 5 | 50 | - | 50 |
| 3 | MENE6029 | Energy Efficient Buildings (Elective-III) | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | MENE6032 | Solid Waste Management (Elective-IV) | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | MENE6037 | Remote Sensing & GIS Applications (Elective-V) | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| | | Total Credit | | | | 16 | | | |
| Semester IV | | | | | | | | | |
| Sl No | Course Code | Name of the Course | | | | | Assessment Pattern | | |
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | MENE8001 | Project (Phase II) | 0 | 0 | 0 | 15 | 50 | - | 50 |
| | | Total Credit | | | | 15 | | | |

**List of Electives**

| Sl No | Course Code | Name of the Electives | | | | | Assessment Pattern | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | C | IA | MTE | ETE |
| 1 | MENE6013 | Solar Energy Technology | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | MENE6015 | Hydrogen & Fuel Cells | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | MENE6019 | Energy Environment Climate Change | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | MENE6027 | Bioenergy Technologies | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | MENE6029 | Energy Efficient Building | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | MENE6032 | Solid Waste Management | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 7 | MENE6034 | Design of Wastewater Treatment & Disposal System | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 8 | MENE6035 | Urban Environmental Quality Management | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 9 | MENE6037 | Remote Sensing & GIS Applications | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 10 | MENE6038 | Application of Bio-technology in Environmental Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 11 | MENE6039 | Risk Assessment and Disaster Management | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 12 | MENE6040 | Mathematical Modelling in Environmental Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 13 | MENE6041 | Clean Development Mechanism & Green Technologies | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 14 | MENE6042 | Environmental Ecology | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 15 | MENE6046 | Environmental Economics, Legislation and Management | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

**Detailed Syllabus**

| Name of The Course | Renewable Energy Technology | | | |
|---|---|---|---|---|
| Course Code | MENE5001 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. Fundamental knowledge to the student about renewable and non-renewable energy.
2. Brief idea to students about types of energy and conversion technologies, processes, systems and devices.
3. Plasticize students to work with instruments
4. Encourage students to take up projects in those areas.
5. Implementation of renewable energy in project and development.

**Course Outcomes**

| | |
|---|---|
| CO1 | Explain the basic principles of various renewable energy conversion processes and devices used therein. |
| CO2 | Understand the relationships between natural resources, consumption, population, economics of consumerism, etc in an environmental context. |
| CO3 | Identify various parameters that influence the performance of devices/processes. |
| CO4 | An understanding the problems of energy distribution, design, plan and execute. |
| CO5 | To make a thought in terms of scientific and technological advancement in the spirit of a sustainable energy. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction to energy and resource** **9 Hours** |
| Introduction to energy and resources – Renewable energy sources - Availability of solar energy – Sun-earth relationships - Estimation of solar radiation using Page-Angstrom method - Solar radiation measurement – Flat plate collectors – Solar water heating systems – Evacuated Tubular Concentrators - Solar air heating systems and applications – Concepts on solar drying, cooking, desalination, solar ponds and solar cooling - Passive heating and cooling of buildings – Basics of solar concentrators and types - Solar thermal power generation. |
| **Unit II:Solar Cell** **10 Hours** |
| Physics of solar cells – Cell types and manufacture – PV applications - Characteristics of cells and module – Performance parameters - Estimation of module power output – PV system configurations – System components: Battery, charge controller and inverter. |
| **Unit III: Biomass** **10 Hours** |
| Biomass to energy conversion processes – Anaerobic digestion, process parameters, biogas composition, digester types, high rate anaerobic conversion systems – Alcohol from biomass – Biodiesel: preparation, characteristics and application - Biomass combustion and power generation – Briquetting – Gasification: Process, types of gasifiers, applications – Waste to energy technologies. |
| **Unit IV: Wind Power** |

| |
|---|
| **7 Hours** |
| **Power in the wind - Types of wind mills – WEG components - Airfoils: lift and drag – Power curves and energy estimation - Micro siting – Indian wind potential. Small Hydro Power: Types, site identification, head and flow measurement, discharge curve, estimation of power potential and system components.** |
| **Unit V: Renewable Energy Technologies** **9 Hours** |
| **Technologies for harnessing other renewable energy sources like geothermal, wave, tidal and ocean thermal energy.** |

**Suggested Reading**


1. **Frank Kreith and D.Yogi Goswami (2007), Handbook of Energy Efficiency and Renewable Energy, CRC Press.**
2. **John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA.**


| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Physico-Chemical, Biological Principles and Processes** | | | | |
| **Course Code** | **MENE5002** | | | | |
| **Prerequisite** | **-** | | | | |
| **Co-requisite** | **-** | | | | |
| **Anti-requisite** | **-** | | | | |
| | **L** | **T** | **P** | **C** | |
| | **4** | **0** | **0** | **4** | |

**Course Objectives**

1. **To study about the solid- liquid- gas interactions**
2. **To understand about process kinetics**
3. **To deal with the microbial applications in environmental engineering**
4. **To study microbial activity and its application to treat wastewater**
5. **To apply microbial kinetics to addressed wastewater treatment problems**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Understand the mass transfer and transport of impurities in system** |
| **CO2** | **Apply the concepts of oxidation-reduction equilibrium** |
| **CO3** | **Study and applying practically about microbial kinetics** |
| **CO4** | **Application of micro-organism for wastewater treatment** |
| **CO5** | **Apply microbial principles to environmental engineering** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Structure and Properties of Water** **8 Hours** |
| **Structure and Properties of Water- their significance in environmental engineering, Sources of Water impurities, Abiotic reactions, Biological metabolism. Solid-Liquid-Gas interactions, Mass transfer and transport of impurities in water, diffusion, dispersion. Physical and Chemical interactions due to various forces, suspensions and dispersions.** |
| **Unit II: Chemical Reactions** **8 Hours** |
| **Chemical reactions, Chemical equilibrium and thermodynamics, Acid-baseequilibria, solubility equilibria, oxidation-reduction equilibria. Process kinetics, reaction rates and catalysis, surface and colloidal chemistry, Adsorption. Settling of particles in water stabilization.** |
| **Unit III: Ecosystem** **8 Hours** |
| **Ecosystems; biotic and abiotic components, biogeochemical cycles, ecology of population; Ecological niche, Mortality and survivorship, Comm Moduley Interactions. typical natural and artificial ecosystems** |
| **Unit IV: Biochemistry** **8 Hours** |

| |
|---|
| **Biochemistry; Biological compounds– enzymes, coenzymes and amino acids, Microbiological concepts; Cells, classification and characteristics of living organisms, Characterization techniques, Reproduction, Metabolism, Microbial growth kinetics.** |
| **Unit V: Applications of Microbiological principles to environmental engineering**<br>**8 Hours** |
| **Applications of Microbiological principles to environmental engineering; assimilation of wastes, engineered systems, Concepts and Principles of carbon oxidation, Nitrification, Denitrification, Methanogenasis, etc., Concepts of quantization of degradable pollutants.** |

**Suggested Reading**


1. Benefield, L.D. Judkins J.F. and Weand B.L. (1982). Process Chemistry for Water and Wastewater Treatment, End ed., Prentice-Hall, Inc, New Jersey, USA
2. Metcalf and Eddy, M.C., "Wastewater Engineering: Treatment, Disposal and Reuse", Tata McGraw-Hill Pulications, New Delhi, 2003


| **Name of The Course** | **Environmental Quality Monitoring** | | | |
|---|---|---|---|---|
| **Course Code** | **MENE5003** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. **To teach students about various water quality parameters and their effect**
2. **Explain brief procedure for collection and preservation of samples of water and wastewater**
3. **Give idea to students about different standard methodologies for sampling and analysis of environment at whole and its constituents like water, wastewater, air and soil**
4. **To teach advance analytical methods for environmental quality monitoring**
5. **Conduct small projects on water quality monitoring of polluted and waste water in field condition**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Schedule field studies and other data acquisition activities to be considered for compliance** |
| **CO2** | **Use a tiered monitoring approach consisting of rapid assessment or screening studies at site** |
| **CO3** | **Supervise monitoring techniques of various environmental parameters** |
| **CO4** | **Generate monitoring data relevant to decision making process** |
| **CO5** | **Manage and report environmental quality data in a way that is meaningful and understandable to intended audience** |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: General Sampling and Analytical Techniques 10 Hours** |
| **General principles for collection of representative sample, frequency of sampling, validation, interpretation and analysis of data, various statistical techniques, quality control, assessment and management.** |
| **Unit II:Methods for Physicochemical Analysis of Water/ Wastewater**<br>**10 Hours** |
| **Gravimetric methods for solids analysis in water and wastewater, determination of acidity, alkalinity and turbidity, analysis of common cations and anions in water/wastewater through various chemical techniques, determination of nitrogen, phosphorus and chemical oxygen demand (COD), acid-base titrations, precipitation titrations, complex metric titrations, oxidation-** |

| |
|---|
| **reduction titrations, working principles of electrodes, different types of electrodes.** |
| **Unit III: Biological Methods and Microbiology 10 Hours** |
| **Biochemical oxygen demand (BOD), MPN test for microbial pollution, plate counts; confirmatory tests for various microbiological agents.** |
| **Unit IV: Air Pollution Measurement 7 Hours** |
| **Sampling techniques for air pollution measurements; analysis of particulates and common chemical air pollutants, analysis of oxides of nitrogen, oxides of sulphur, carbon monoxide, hydrocarbon and poly aromatic hydro carbons.** |
| **Unit V: Advanced Analytical Methods 9 Hours** |
| **Working principles of Spectrophotometric methods; Nephelometric methods; Atomic absorption spectroscopy and its various analytical versions; Ion chromatography, High performance liquid chromatography, CHNO/S Analyzer, TOC analyzer and other advanced analytical instruments.** |

**Suggested Reading**


1. **Metcalf and Eddy, (2003), Wastewater Engineering Treatment and Reuse, 4th edition, Tata McGraw Hill Education Private Limited, ISBN:978-00-704-9539-5.**
2. **MN.Rao, H.V.N.Rao, (2007), Air Pollution, Tata McGraw Hill Publishing Company Limited, ISBN: 978-00-745-1871-7**


| **Name of The Course** | **Energy Auditing Conservation and Management** | | | |
|---|---|---|---|---|
| **Course Code** | **MENE5004** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. **To teach the basic concepts of energy audit and management.**
2. **Give brief knowledge about mathematical calculation and modelling of energy performance**
3. **Teach students about data collection and analysis**
4. **The energy auditing procedures, techniques, policy planning, implementation and energy audit instrument**
5. **To give a broadly knowledge about planning and management for economic growth**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Understand the general aspect of energy auditing and management** |
| **CO2** | **Development of knowledge about the energy auditing procedures, techniques, policy planning and implementation.** |
| **CO3** | **Understand about energy audit instrument.** |
| **CO4** | **Mathematical approach of data collection and analysis.** |
| **CO5** | **Design of energy modelling and optimization** |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: General Aspects 8 Hours** |
| **General Philosophy and need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. Energy Audit: Need, Types, Methodology and Approach. Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency,** |

| |
|---|
| **Optimizing the input energy requirements, Fuel and Energy substitution.** |
| **Unit II: Procedures & Technique** **10 Hours** |
| **Data gathering : Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering. Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.** |
| **Unit III: Energy Policy Planning and Implementation** **10 Hours** |
| **Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager, Accountability. Motivating – Motivation of employees, Requirements for Energy Action Planning. Information Systems: Designing, Barriers, Strategies, Marketing and Communicating Training and Planning.** |
| **Unit IV: Energy Balance & MIS** **7 Hours** |
| **First law of efficiency and Second law of efficiency, Facility as an Energy system, Methods for preparing process flow, Materials and Energy Balance diagram, Identification of losses, Improvements. Energy Balance sheet and Management Information System (MIS) Energy Modelling and Optimization.** |
| **Unit V: Energy Audit Instruments** **8 Hours** |
| **Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy** |

**Suggested Reading**


1. Stanley E. Manahan (2005), Environmental Chemistry, 8th Edition, CRC Press, ISBN: 978-15-667-0633-9.
2. Clair N Sawyer, Perry L. McCarty and Gene F. Parkin (2002), Chemistry for Environmental Engineering and Science, McGraw-Hill Science.


| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Renewable Energy Technology Lab** | | | |
| **Course Code** | **MENE5005** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **0** | **0** | **2** | **1** |

**Course Objectives**

**1. To impart knowledge in the area of biomass to energy**
**2. Working principle knowledge of instruments**
**3. Brief knowledge about various renewable energy parameters**
**4. Knowledge about handling the instruments and how to operate in filed**
**5. The role of instruments in different engineering applications.**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Study the devices used to measure various forms of energy.** |
| **CO2** | **Understand the basic working principle of energy measuring devices** |
| **CO3** | **Knowledge of various flow parameters** |
| **CO4** | **Handling efficiency of instruments and problem solving** |
| **CO5** | **Technical approach of the instruments in field condition** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **50** | **-** | **50** | **100** |

**Course Content:**

| |
|---|
| **1. Determination of proximate analysis (Moisture content, ash, Volatile matter & fixed carbon) for a Given Biomass Sample.** |

**2. Determination of Total solids, volatile Solids and calorific value for a given organic Biomass Sample.**
**3. Determination of elemental analysis (chemical method) for a Given Biomass Sample.**
**4. Determination of C/N Ratio for a given organic Biomass Sample.**
**5. Determination of Chemical Oxygen Demand, BOD, Total dissolved solids (TDS) and pH for a Given Slurry or Liquid Sample.**
**6. Determination of Dissolved Oxygen & Biochemical in a Liquid Slurry Waste Sample.**
**7. Determination of Calorific Value of a solid and liquid Biomass Sample using Bomb calorimeter.**
**8. To study the Effect of Different Loading Rates, Total Volatile Solids and Hydraulic Retention time on Generation of Biogas in Batch Type Digesters.**
**9. Determination of Lignin, Cellulose, Hemicelluloses in a Given Biomass Sample.**
**10. Determination of Potassium, Sodium and Phosphorous in a Given Waste Slurry Sample.**
**11. Determination of Crude Protein in a Given Biomass Sample.**
**12. Study of Gasifier and its performance evaluation with solid and loose biomass.**
**13. Characterization of liquid biomass (Viscosity, density, flash/fire point, cloud point) and its comparison with diesel**

**Suggested Reading**

1. **Frank Kreith and D.Yogi Goswami (2007), Handbook of Energy Efficiency and Renewable Energy, CRC Press.**
2. **John Twidell and Tony Weir (2006), Renewable Energy Resources, 2nd Edition, Taylor & Francis, USA**

| Name of The Course | Environmental Quality Monitoring Lab | | | | |
|---|---|---|---|---|---|
| Course Code | MENE5006 | | | | |
| Prerequisite | - | | | | |
| Co-requisite | - | | | | |
| Anti-requisite | - | | | | |
| | L | T | P | C | |
| | 0 | 0 | 4 | 2 | |

**Course Objectives**

**1. To impart knowledge in the area of sampling and statistical analysis**
**2. Working principle knowledge of instruments**
**3. Brief knowledge about various parameters**
**4. Knowledge about handling the instruments and how to operate in field**
**5. The role of instruments in different engineering applications.**

**Course Outcomes**

| | |
|---|---|
| CO1 | Learn various instruments process and about their features |
| CO2 | How to handle the instruments |
| CO3 | Supervise monitoring techniques of various environmental parameters |
| CO4 | Generate monitoring data and their application in various treatment process |
| CO5 | Manage and report environmental quality data in a way that is meaningful and understandable to intended project |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

**1. Estimation of pH**
**2. Determination of Total, suspended, dissolved volatile & fixed residue in a waste/water sample**
**3. Determination of Turbidity**
**4. Determination of the Carbonate, Bicarbonate, and Hydroxide Alkalinity**
**5. Determination of the type and Extend of Acidity**
**6. Estimation of the Optimum Dose of Coagulants for Coagulation**
**7. Estimation of the Hardness of water (EDTA Method)**
**8. Estimation of the Chloride Concentration.**
**9. Determination of the Dissolved Oxygen (DO) and percentage saturation**
**10. Determination of Biochemical Oxygen Demand (BOD) of wastewater**
**11. Determination of Chemical Oxygen Demand (COD) of wastewater**

**Suggested Reading**

1. Metcalf and Eddy, (2003), Wastewater Engineering Treatment and Reuse, 4th edition, Tata McGraw Hill Education Private Limited, ISBN:978-00-704-9539-5.
2. MN.Rao, H.V.N.Rao, (2007), Air Pollution, Tata McGraw Hill Publishing Company Limited, ISBN: 978-00-745-1871-7

| Name of The Course | Energy, Instrumentation, Measurement & Control | | | |
|---|---|---|---|---|
| Course Code | MENE6001 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

**1. To impart knowledge in the area of numerical integration and Calculus**
**2. Working principle knowledge of energy meter**
**3. Brief knowledge about various flow parameters**
**4. Knowledge about handling the instruments and how to operate in filed**
**5. The role of instruments in different engineering applications.**

**Course Outcomes**

| | |
|---|---|
| CO1 | Study the devices used to measure various forms of energy. |
| CO2 | Understand the basic working principle of energy measuring devices |
| CO3 | Knowledge of various flow parameters |
| CO4 | Handling efficiency of instruments and problem solving |
| CO5 | Technical approach of the instruments in field condition |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| Unit I: Electrical Energy Metering<br>9 Hours |
|---|
| Electrical energy meter, One –Phase energy meters, Three Phase Energy meters, working principle, various compensation, and Automatic meter reading systems. |
| Unit II:Thermal Energy Metering<br>10 hours |
| Combustion analyser, Fuel efficiency monitor , Flue gas analyzer, Thermometers, Thermocouples & RTDs, Potentiometric & Paperless Recorders, I/P Converters, Temperature Transmitters, Optical Pyrometer, Digital indicators, PID Controllers, Loop Powered Indicators & Isolators, BTU meters, Thermistors, Heat Flux sensor. |
| Unit III: Air Flow Metering<br>10 Hours |
| Air flow meters: vane (flap) type air flow meters and “hot wire" and "hot film" air mass meters. Anemometer, types and its classification, working principle. |
| Unit IV: Gas Flow Metering<br>7 Hours |
| Types and its basic working principle, Odometer. |
| Unit V:Fluid Flow Metering<br>9 Hours |
| Classification of fluid flow meters based on the operating principle- Differential Pressure Flowmeters, Velocity Flow meters, Positive Displacement Flowmeters, Mass Flowmeters, Open Channel Flowmeters, Types:-Orifices, Venturies, Nozzles, Rotameters, Pitot Tubes, Calorimetrics, Turbine, Vortex, Electromagnetic, Doppler, Ultrasonic, Thermal, Coriolis |

**Suggested Reading**

1. **Electrical Measurements and Measuring Instruments by A.K Sawhney**
2. **Flow measurement: practical guides for measurement and control by David W. Spitzer, Instrument Society of America.**

| Name of The Course | Environmental Audit & Impact Assessment |
|---|---|
| Course Code | MENE6002 |
| Prerequisite | - |

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | | **L** | **T** | **P** | **C** |
| | | **3** | **0** | **0** | **3** |

**Course Objectives**

1. **To teach the basic concepts of environmental audit impact assessment and policy.**
2. **To provide a critical overview of the theory and practice of EIA as operated internationally to those students who need to understand EIA**
3. **Field visit and EIA study of different field cases**
4. **How to conduct project on sustainability of environment**
5. **To teach various conventions and laws involving EIA.**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Define EIA, different types of EIAs and benefits of EIA** |
| **CO2** | **Describe the role of EIA in sustainable development** |
| **CO3** | **Skill development for project planning process** |
| **CO4** | **Take a decision-making process in environmental clearance and public relation** |
| **CO5** | **Make a plan for International environmental issues and sustainable development** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: General Aspects** **9 Hours** |
| **Definition of Environmental Audit (EA). Types of environmental audits. Policies and legislation relating to environmental audits. Conducting an audit. Audit reports. Relationship between an environmental audit and an EIA. The benefits of EA. Guidelines for EAs (General Principles, Criteria, evidence and findings, Reporting). EA objectives, roles and responsibility. EA as environmental management tool for small scale and large scale enterprises. EA and sustainable development. Responsibilities in conducting EAs. The benefits of database in EAs. Future Direction of EA** |
| **Unit II: EIA-I** **10 Hours** |
| **Economic development, population growth and impact on the environment. Introduction to Environmental Impact assessment. The history of Environmental Impact assessment (EIA). Purpose and aims of EIA. EIA administration and practice Converging opportunities (i.e. development and environmental protection are complimentary), environmental management and sustainable development.** |
| **Unit III: EIA-II** **10 Hours** |
| **EIA in project planning and management. The costs and benefits of EIA. Introduction to the key principles and elements of EIA, core values (sustainability, integrity, utility). EIA guiding principles (e.g. participation, transparency, flexibility, etc). Introduction to the main features of the EIA system. Role of public participation stages that follow EIA Understanding of the strengths and limitations of EIA.** |
| **Unit IV: Environmental Policy I** **7 Hours** |
| **Overview of the legislative and institutional characteristics essential for the support of a national EIA system. Factors that help to establish an effective national EIA system. Steps involved in establishing and modifying a national EIA system.** |
| **Unit V: Environmental Policy II** |

| 9 Hours |
|---|
| **The level of public involvement in EIA and the relative advantages and disadvantages they offer. Techniques for communicating with the public. Consensus building and dispute resolution mechanisms. International environmental issues and sustainable development plans. International environmental laws and policies of relevance to EIA -Treaties, conventions etc.** |

**Suggested Reading**


1. Canter L.W. Environmental Impact Assessment. McGraw-Hill, Inc.
2. Wathern P. 1995. Environmental Impact Assessment: Theory and Practice. Biddles Ltd, Guildford and King's Lynn.


| Name of The Course | Design of Water and Wastewater Treatment Systems | | | | |
|---|---|---|---|---|---|
| Course Code | MENE6003 | | | | |
| Prerequisite | - | | | | |
| Co-requisite | - | | | | |
| Anti-requisite | - | | | | |
| | | L | T | P | C |
| | | 3 | 0 | 0 | 3 |

**Course Objectives**

1. **various water treatment processes and their designing criteria**
2. **implementation of technologies in wastewater treatment in order to make water safe to drink**
3. **to teach various options available in treatment of waste water for recycle and safe disposal**
4. **design of bioreactors for degradation of nutrients**
5. **application of wastewater treatment in field by research projects**

**Course Outcomes**

| | |
|---|---|
| CO1 | Understand various unit operations involved in water treatment and design various water treatment units required |
| CO2 | Planning and siting of water treatment plant |
| CO3 | Effect of wastes disposal to water |
| CO4 | Design of physical units for waste treatment. |
| CO5 | Design of bioreactors for biodegradation of wastewater treatment |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| Unit I: Definitions and Concepts<br>9 Hours |
|---|
| **Water sources, Philosophy of water treatment, Review of water quality characteristics and potable water standards, Estimation of water quantity, Theory and design of Conventional Unit Operations used in Water Treatment: Screening, Sedimentation, Floatation, coagulation, flocculation, filtration, softening and disinfection processes.** |
| **Unit II: Theory and Design of Advanced Unit Operations used in Water Treatment**<br>**10 Hours** |
| **Membrane processes, Ion Exchange, Aeration/stripping, Precipitation, Adsorption, Oxidation-reduction and advanced oxidation processes; Water Treatment Plant Design; Selection of raw water source, Planning and siting of water treatment plant, Chemical requirement and residuals management.** |
| **Unit III: Philosophy of Wastewater Treatment**<br>**10 Hours** |
| **Philosophy of wastewater Treatment, Review of Wastewater quality parameters and discharge standards for aquatic and land disposal, Estimation of wastewater quantity; Wastewater Collection; Design of sewers and sewerage systems** |
| **Unit IV: Wastewater Disposal**<br>**7 Hours** |

| |
|---|
| **Disposal to inland waters such as lakes reservoirs, rivers and streams, disposal to sea, disposal on Land. Wastewater treatment; Preliminary treatment, Bar-rack, Screens, Grit chamber, Equalization tank, Primary sedimentation** |
| **Unit V: Secondary Treatments** **9 Hours** |
| **Aerobic processes, Anaerobic processes. Tertiary treatment, Nutrient removal, Residual management, Design; Planning and setting of Wastewater treatment plant, Chemical requirements and material balance.** |

**Suggested Reading**


1. Metcalf and Eddy, M.C., "Wastewater Engineering: Treatment, Disposal and Reuse", Tata McGraw-Hill Publications, New Delhi, 2003
2. Benefield, L.D. Judkins J.F. and Weand B.L. (1982). Process Chemistry for Water and Wastewater Treatment, End ed., Prentice-Hall, Inc, New Jersey, USA


| **Name of The Course** | **Environmental Quality Monitoring** | | | |
|---|---|---|---|---|
| **Course Code** | **MENE6004** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

**1. The basics concept of air pollution**
**2. Instruments of monitoring of air quality**
**3. Technology required controlling air pollution**
**4. Effect of air pollution on environment**
**5. How to apply study for clean air development**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Brief knowledge and experience to identify the type the source of pollutant.** |
| **CO2** | **Monitoring of air quality by different instruments** |
| **CO3** | **Control of air pollution by using different ECS.** |
| **CO4** | **Field project on remediation of air quality** |
| **CO5** | **Use of different methods for air quality improvement** |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Air Pollution & Classification** **9 Hours** |
| **Definition, Air Quality, Classification of Air Pollutants.** |
| **Unit II: Effects of Air Pollution** **10 Hours** |
| **Effects of Air pollution on human, plant and animal, Air Pollution Episodes, management and sustainable development.** |
| **Unit III: Air pollution Monitoring** **10 Hours** |
| **Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of $SO_2$, Nox, CO, Oxidants and Ozone.** |
| **Unit IV: Meteorology & Dispersion of pollutants** **7 Hours** |
| **Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths, Plume Rise and dispersion.** |
| **Unit V: Emission Control System** **9 hours** |
| **Air pollution control technologies for particulates and gaseous contaminants, Gravity settlers, Electrostatic precipitators, Bag Filters, Scrubbers, Cyclone, control for moving sources.** |

**Suggested Reading**


1. N.Rao& H V N Rao (2000), Air pollution, Tata McGraw Hill Publishing Ltd.
2. Pollution Control Technology Handbook, Second Edition" by Karl B Schnelle Jr and Russell F Dunn

| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Energy Environment & Climate Change** | | | | |
| **Course Code** | **MENE6019** | | | | |
| **Prerequisite** | **-** | | | | |
| **Co-requisite** | **-** | | | | |
| **Anti-requisite** | **-** | | | | |
| | **L** | **T** | **P** | **C** | |
| | **3** | **0** | **0** | **3** | |

**Course Objectives**

1. To provide knowledge related to the broad field of environmental risk assessment
2. **Steps involved in the risk assessment process, including statistical characterization of observed data**
3. **Knowledge about tools that can be used in defining environmental risks, particularly as related to human health.**
4. **To develop practical skills in disaster mitigation, planning, response and post disaster rehabilitation, particularly related to health and public health.**
5. **To provide knowledge related to cyber and important legal provision for sustainable development advancement.**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **To gain knowledge related to the broad field of environmental risk assessment** |
| **CO2** | **Statistical characterization of field data** |
| **CO3** | **Use of tools for environmental risks, particularly as related to human health** |
| **CO4** | **To apply biotechnological concept and tools for green production technologies** |
| **CO5** | **Gain knowledge on eco-sustainable waste management ensuring sustainable development** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Energy Sources** **9 Hours** |
| **Definition, Modules, Forms of Energy, Power, Origin of Fossil fuels, World and Indian Resources of Coal, Oil, Natural gas, Nuclear, Geothermal, Renewable Energy potential : Solar Energy, Wind Energy, Bio-Energy, Hydro, Tidal, Ocean , Nuclear Energy, Nuclear Fission and Fusion , Geothermal Energy.** |
| **Unit II: Energy Scenario** **10 Hours** |
| **Global Energy Scenario: Energy consumption pattern in various sectors, Impact on economy, India`s Energy Scenario, Urban and Rural energy consumption patterns, Impact of Energy on Development, Energy Infra structure in India** |
| **Unit III: Impact of Energy project on Environment** **10 Hours** |
| **Overview of global environmental problems, Environmental degradation due to Energy production and use, Pollution due to thermal power stations , Environmental aspects of Wind Energy Farms ,Environmental aspects of Nuclear power generation, Nuclear waste disposal, Impact of Hydro power generation on Ecology and Environment, Guidelines for Environmental impact assessment (EIA) of Energy Projects** |
| **Unit IV: Climate Change Concern** **7 Hours** |
| **Green House Gas Emissions, Depletion of Ozone layer, Global Warming, Climate Change Concerns, Climate Change in India, Kyoto protocol, Clean Development Mechanism [CDM], Carbon Fund Concept of Carbon credit** |
| **Unit V: Climate Change Policy Issues** **9 Hours** |
| **Impact of Climate Change on Glaciers, Rivers and Water Resources, Climate Change Policy Issues in Himalayas, International Status of Climate Change Policies, Indian Action Plan on Climate Change** |

**Suggested Reading**

1. **A K De (2001), Environmental Concerns, New Age Publications Pvt Ltd.**

2. P.S.R. Murthy (1994), Power System Operation and Control, Tata McGraw-Hill Publication

| Name of The Course | Risk Assessment and Disaster Management | | | |
|---|---|---|---|---|
| Course Code | MENE6039 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To impart the knowledge of modern energy and climate change
2. Lays the foundation for energy conservation by analysing various schemes, which is of prime importance in the modern energy crisis
3. To conduct energy audit and hence suggest means to improve energy management
4. To understand the importance of economic dispatch and unit commitment problem
5. This subject is taught to impart knowledge in environmental degradation due to the technical advancement.

**Course Outcomes**

| | |
|---|---|
| CO1 | Current emerging technologies and conduct energy audit and hence suggest means to improve energy management |
| CO2 | India's stand in terms of various technologies |
| CO3 | Environmental impacts due to energy production |
| CO4 | Measures taken to control the global environmental changes |
| CO5 | Understand the importance of economic dispatch and unit commitment problem |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Risk Assessment** **9 Hours** |
| **Introduction- Methodologies and Guidelines: Principles, Code of practice – Appointment of personnel and their responsibilities– Emergency plans: onsite and offsite. Steps in risk assessment: Identification of risk, Extent of risk and disaster, Risk-Based Decisions for Corrective Action –Timely updation. Developing a Site Conceptual Model -Focusing on Risk-Based Decisions in Corrective Action – Risk Assessment: Dose Response and Target Level Calculations-Experiences in Environmental Risk Assessment.** |
| **Unit II: Occupational Health & Safety** **10 Hours** |
| **Occupational risk analysis survey and health evaluation, behavioral studies, occupational injury, disease reporting, investigation: monitoring and control of environmental hazards. Occupationally induced illness, non-occupational illness, and discomfort at work, the epidemiological approach, occupational health practice: investigation, monitoring, control, examples of occupational health hazards: nasal cancer, asbestosis, bronchitis, heart disease. Occupational health services.** |
| **Unit III: Methodologies and Management Techniques** **10 Hours** |
| **Risk assessment techniques for accidental release of toxic and inflammable materials, hazard analysis, potential risk, conceivable release mechanisms and release rates, fire and explosion hazards and simplified models for their assessment. Operations Management(OM),Risk Assessment and Disaster Response, Quantification Techniques, NGO Management, SWOT Analysis based on Design &Formulation Strategies, Insurance & Risk Management.** |
| **Unit IV: Disaster Management** **7 Hours** |
| **Introduction & Dimensions of Natural & Anthropogenic Disasters, Principles/Components of Disaster** |

| |
|---|
| **Management, Organizational Structure for Disaster Management, Disaster Management Schemes/SOPs, Natural Disasters and Mitigation Efforts, Flood Control, Drought Management, Cyclones, Avalanches, Mangroves, Land Use Planning, Inter-Linking of Rivers, Role of Union/States, Role of Armed Forces/Other Agencies in Disasters, Role of Financial Institutions in Mitigation Effort, Group Dynamics, Concept of Team Building, Motivation Theories and Applications, School Awareness and Safety Programs, Psychological and Social Dimensions in Disasters, Trauma and Stress, Emotional Intelligence, Electronic Warning Systems.** |
| **Unit V: Use of Information systems, Experiences and case studies**<br><br>**9 Hours** |
| **Recent Trends in Disaster Information Provider, Geo-Informatics in Disaster Studies, Cyber Terrorism, Remote Sensing &GIS Technology, Laser Scanning Applications in Disaster Management, Statistical Seismology, Quick Reconstruction Technologies, Role of Media in Disasters, Management of Epidemics, Bio-Terrorism, Forecasting / Management of Casualties. Important Statutes/ Legal Provisions, IEDs/Bomb Threat Planning, NBC Threat and Safety Measures, Forest Fires.** |

**Suggested Reading**


1. Rao V. Kolluru, "Environmental Strategics hand book", Mc-graw Hill Inc., New York, 1994.
2. **BrockNeely.W&BlanG.E,"EnvironmentalExposurefromchemicals,VolumeII,ChcPressIunc., Florida,1989.**


| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Seminar** | | | |
| **Course Code** | **MENE6005** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **0** | **0** | **0** | **1** |

**Course Objectives**

**1. To prepare students to compete for a successful career in Energy & Environmental Engineering profession through global education standards.**
**2. To enable the students to aptly apply their acquired knowledge in basic sciences and mathematics in solving Energy & Environmental Engineering problems.**
**3. To produce skilful graduates to analyze, design and develop a system/component/ process for the required needs under the realistic constraints.**
**4. To train the students to approach ethically any multidisciplinary engineering challenges with economic, environmental and social contexts**
**5. To create an awareness among the students about the need for lifelong learning to succeed in their professional career**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **To demonstrate the ability to identify, formulate and solve engineering problems.** |
| **CO2** | **To demonstrate the ability to design and conduct experiments, analyze and interpret data.** |
| **CO3** | **The ability to visualize and work on laboratory and multi-disciplinary tasks.** |
| **CO4** | **To demonstrate the skills to use modern engineering tools, software's and equipment to analyze problems.** |
| **CO5** | **To demonstrate the knowledge of professional, ethical responsibilities and in both verbal and written form.** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **50** | **-** | **50** | **100** |

| Name of The Course | Energy, Instrumentation, measurement & Control Lab | | | |
|---|---|---|---|---|
| Course Code | MENE6006 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To impart knowledge in the area of numerical integration and Calculus
2. Working principle knowledge of energy meter
3. Brief knowledge about various flow parameters
4. Knowledge about handling the instruments and how to operate in filed
5. The role of instruments in different engineering applications.

**Course Outcomes**

| | |
|---|---|
| CO1 | Study the devices used to measure various forms of energy. |
| CO2 | Understand the basic working principle of energy measuring devices |
| CO3 | Knowledge of various flow parameters |
| CO4 | Handling efficiency of instruments and problem solving |
| CO5 | Technical approach of the instruments in field condition |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

1. Determination of electrical Energy in One –Phase & Three Phase energy meters,
2. Fuel efficiency by Flue gas analyzer,
3. Fuel efficiency Thermometers,
4. Determine the difference in potential by Potentiometric
5. Measurement of temperature and converts current signals by Temperature Transmitters
6. Determination of intensity of light by Optical Pyrometer
7. Measurement of air flow in Air flow meters
8. Determination of speed of airflow in Anemometer
9. Measurement of volumetric flow rate of fluid by Rotameter
10. Determination fluid flow velocity by Pitot Tube
11. Measurement of mass flow rate by Mass Flow meters
12. Determination of velocity of water by Open Channel Flow meters

**Suggested Reading**

1. A.K Sawhney, Electrical Measurements and Measuring Instruments.
2. David W. Spitzer, Flow measurement: practical guides for measurement and control, Instrument Society of America

| Name of The Course | Project Phase-I | | | |
|---|---|---|---|---|
| Course Code | MENE7002 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 0 | 5 |

**Course Objectives**

1. To provide a comprehensive understanding of the concepts and methodologies for project identification, project preparation, project evaluation and project financing
2. To make the students understand the project cycle and their wide socio-economic and environmental impacts
3. To make the students learn how to evaluate a project in view of global concern about sustainable development of energy and environment projects
4. To make students to develop lab scaled experimental setup to addressed environmental problems
5. To help students to carryout case studies on various environmental problems

**Course Outcomes**

| | |
|---|---|
| CO1 | Identify various energy and environmental features of a project |

| | |
|---|---|
| CO2 | Small projects for environmental development and sustainability |
| CO3 | Develop a project with suitable technology, and environmental impacts |
| CO4 | Solve complex environmental problems by different tools and techniques |
| CO5 | Carry out techno-economic evaluation of energy projects with environmental considerations |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

| Name of The Course | Energy Efficient Buildings | | | | |
|---|---|---|---|---|---|
| Course Code | MENE6029 | | | | |
| Prerequisite | - | | | | |
| Co-requisite | - | | | | |
| Anti-requisite | - | | | | |
| | | L | T | P | C |
| | | 3 | 0 | 0 | 3 |

**Course Objectives**

1. Importance of Energy- Efficient Buildings within the context of Energy issues in the 21st century.
2. The concept of Energy efficiency, Renewable sources of energy and their effective adaptation in green buildings
3. Understanding of Building Form and Fabric, Infiltration, ventilation, Lighting, cooling and water conservation.
4. The importance of Environmental Management as well as Environmental Impact Assessment methods in Energy efficient buildings.
5. To help students understanding energy flow and its conservation.

**Course Outcomes**

| | |
|---|---|
| CO1 | Understand why buildings should be made energy efficient. |
| CO2 | Have a fuller grasp on Renewable Energy mechanisms such as Passive Solar heating and collection, Photovoltaics. |
| CO3 | Ground source heat pumps, and their adaption to green building concepts. |
| CO4 | Understand the concepts of Site and Climate, Building Form, Building Fabric, Infiltration and ventilation, Lighting, Heating, Cooling, Energy Management and water conservation. |
| CO5 | Environmental Impact Assessment study for Energy Efficient Buildings. They shall be equipped with the associated cutting-edge management strategies. |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Green Buildings, Energy and Environment** **9 hours** |
| Green Buildings within the Indian Context, Types of Energy, Energy Efficiency and Pollution, Better Buildings, Reducing energy consumption, Low energy design |
| **Unit II: Renewable Energy, Site and Climate** **10 hours** |
| Renewable Energy sources that can be used in Green Buildings – Solar energy, Passive Solar Heating, Passive Solar collection, Wind and other renewables. A passive solar strategy, Photo-voltaics, Climate and Energy, Macro and Microclimate. Indian Examples. |
| **Unit III: Building Form and Fabric** **10 hours** |
| Building Form – Surface area and Fabric Heat Loss, utilizing natural energy, Internal Planning, Grouping of buildings. Building Fabrics- Windows and doors, Floors, Walls, Masonry, Ecological walling systems, Thermal Properties of construction material. |
| **Unit IV: Infiltration, Ventilation, Lighting, Cooling and Water Conservation** |

| |
|---|
| 7 hours |
| Infiltration and ventilation, Natural ventilation in commercial buildings, passive cooling, modeling air flow and ventilation, Concepts of daylight factors and day lighting, daylight assessment, artificial lighting, New light sources. Cooling buildings, passive cooling, and mechanical cooling. Water conservation- taps, toilets and urinals, novel systems, collection and utilization of rain water. |
| **Unit V: Energy Awareness** 9 hours |
| Energy awareness, monitoring energy consumption, Building Environmental Assessment - environmental criteria - assessment methods - assessment tools (e.g. LEED). Ecohomes, Sustainable architecture and urban design – principles of environmental architecture. Benefits of green buildings – Energy Conservation Building code - NBC |
| **Unit VI: Discussion on Latest Research Paper** 2 Hours |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**


1. William T. Meyer., Energy Economics and Building Design., New York: McGraw- Hill, Inc
2. Public Technology, Inc. (1996). Sustainable Building Technical Manual: Green Building Design, Construction, and Operations. Public Technology, Inc., Washington, DC.


| | |
|---|---|
| Name of The Course | Solid Waste management |
| Course Code | MENE6032 |
| Prerequisite | - |
| Co-requisite | - |
| Anti-requisite | - |

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives**

1. To gain insight into collection, transfer and transport of municipal solid waste
2. Understand the design and operation of municipal solid waste landfill
3. Understand the design and operation of resource recovery facility
4. Understand the design and operation of waste to energy facility
5. Understand the effect of waste management on environmental sustainability

**Course Outcomes**

| | |
|---|---|
| CO1 | Understand solid waste and its composition |
| CO2 | Understand method solid waste collection and transportation |
| CO3 | Understand various processes involved in solid waste collection, segregation and transportation. |
| CO4 | Design solid waste disposal facility. |
| CO5 | Understand the identification of hazardous wastes |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Solid waste and its composition** 9 Hours |
| Legal and Organizational foundation: Definition of solid waste–waste generation–major legislation, monitoring responsibilities, sources and types of solid waste – sampling and characterization – Determination of composition of MSW–storage and handling of solid waste – Future changes in waste composition. |
| **Unit II: Solid waste collection and transportation** 10 Hours |

| |
|---|
| **Waste collection systems, analysis of collection system–alternative techniques for collection system. Need for transfer operation, transport means and methods, transfer station types and design requirements.** |
| **Unit III: Process of Solid Waste and Energy recovery** **10 Hours** |
| **Unit operations for separation and processing, Materials Recovery facilities, Waste transformation through combustion and aerobic composting, anaerobic methods for materials recovery and treatment – Energy recovery – Incinerators.** |
| **Unit IV: Disposal of Solid Wastes** **7 Hours** |
| **Land farming, deep well injections. Landfills: Design and operation including: site selection, Geo-environmental investigations, engineered sites, liners and covers, leachate control and treatment, gas recovery and control, including utilization of recovered gas (energy), and landfill monitoring and reclamation,, Requirements and technical solution, designated waste landfill remediation–Integrated waste management facilities. TCLP tests and leachate studies. Economics of the on-site v/s offsite waste management options. Natural attenuation process and its mechanisms.** |
| **Unit V: Household Hazardous Waste Management** **9 Hours** |
| **Design practices of solid wastes. Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport. Regulatory requirements for identification, characterization and disposal of hazardous, non-hazardous waste.** |
| **Unit VI: Discussion on Latest Research Paper** **2 Hours** |
| **This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.** |

**Suggested Reading**


1. **George Techobanoglous et al, "Integrated Solid Waste Management", McGraw-Hill Publication, 1993.**
2. **Frank Kreith and George Tchobanoglous, 'Handbook of Solid Waste Management', McGraw Hill Publication**


| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Remote Sensing & GIS Applications** | | | |
| **Course Code** | **MENE6037** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

**1. Basic concept of Remote Sensing**

**2. Knowledge of Geographic Information Systems with its applications.**

**3. History of development of GIS**

**4. Concepts of digital image processing**

**5. Applications of GIS and remote sensing**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Basic remote sensing concepts and its characteristics** |
| **CO2** | **GIS and its requirements** |
| **CO3** | **Data management with GIS** |
| **CO4** | **Carry out analysis and interpretation of GIS results** |
| **CO5** | **Modelling through GIS** |
| **CO6** | **Discuss on latest research paper.** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Basic concepts of remote Sensing** **9 Hours** |

| |
|---|
| Basic concepts of Remote Sensing - Introduction to remote sensing – Electromagnetic radiation - Characteristic of real remote sensing systems–Plat forms– Satellite-Indian remote sensing satellite-Sensors |
| Unit II: Image Processing<br>10 Hours |
| Image processing - Elements of image interpretation –Concepts of digital image processing |
| Unit III: Basic concepts of GIS<br>10 Hours |
| Basic concepts of GIS – Introduction to GIS-History of development of GIS-Elements of GIS-Computer hardware and software |
| Unit IV: Map Overlay<br>7 hours |
| Map overlay-Vector and raster data model-Mapping concept- Data storage and data base management- Development of map overlay – Overlay operation |
| Unit V: Applications of GIS and Remote Sensing<br>9 Hours |
| Applications of GIS and remote sensing in resource management |
| Unit VI: Discussion on Latest Research Paper<br>2 Hours |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**


1. A.N. Patel and Surendra Singh (1999), Remote Sensing Principles and Applications, Scientific Publisher.
2. A. Burrough (2000), Principle of Geographical Information Systems for Land Resources Assessment, Clarendon Press, Oxford.


| | | | | |
|---|---|---|---|---|
| Name of The Course | Project Phase (II) | | | |
| Course Code | MENE8001 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 0 | 15 |

**Course Objectives**

1. To provide a comprehensive understanding of the concepts and methodologies for project identification, project preparation, project evaluation and project financing
2. To make the student understand the project cycle and their wide socio-economic and environmental impacts
3. To make the student learn how to evaluate a project in view of global concern about sustainable development of energy and environment projects

**Course Outcomes**

| | |
|---|---|
| CO1 | Identification various energy and environmental features of a project |
| CO2 | Laboratory and field based study |
| CO3 | Small projects for environmental development and sustainability |
| CO4 | Develop a project with suitable technology, and environmental impacts |
| CO5 | Solve complex environmental problems by different tools and techniques |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

| | | | | |
|---|---|---|---|---|
| Name of The Course | Solar Energy Technology | | | |
| Course Code | MENE6013 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To impart the knowledge in the area of solar energy
2. Solar energy and the effective utilization to improve energy management
3. To understand the importance of economic dispatch and unit commitment problem
4. Solar energy using different technologies.
5. Design of liquid and air heaters

**Course Outcomes**

| | |
|---|---|
| CO1 | Atmospheric attenuation |
| CO2 | Fixing of Solar energy |
| CO3 | Application of energy into daily life activities |
| CO4 | Find out heat removal rate |
| CO5 | Design of active systems for liquid and air heaters |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Solar Radiation** **9 hours** |
| Source of radiation – Sun earth relationship-extra-terrestrial radiation.– Atmospheric attenuation – Terrestrial radiation-radiation on a horizontal surfaces and inclined planes relations between horizontal radiation and inclined surfaces – relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation- pyrohelio meter, pyrano meter, pyro geo meter, net pyradiometer-sunshine recorder . |
| **Unit II: Solar Collectors – Flat Plate Collection** **10 hours** |
| Design considerations – classification- Flat plate collectors- air heating collectors liquid heating –Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors-for efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors |
| **Unit III: Concentric Solar Collectors and Thermal Application** **10 hours** |
| Concentric collectors-Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats. Solar powered absorption A/C system (Ammonia/water) solar water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker. |
| **Unit IV: Simulation and Energy Storage** **7 hours** |
| Simulation in Solar Process Design-TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change- Glauber's salt organic compounds -solar ponds. |
| **Unit V: Solar PV System** **9 Hours** |
| Photo- voltaic cell – characteristics-maximum power- tracking-cell arrays-power electric circuits for output of solar panels--inverters-batteries-charge regulators, Construction concepts. |
| **Unit VI: Discussion on Latest Research Paper** **2 Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. DuffieJ.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley& Sons Inc., Newyork, -1991

2. G.N. Tiwari. "Solar Energy: Fundamentals, Design, Modelling and Applications", Third Reprint, Narosa Publishing House, New Delhi-2006

| Name of The Course | Hydrogen Fuel Cells | | | |
|---|---|---|---|---|
| Course Code | MENE6015 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. **Importance of hydrogen as a future energy carrier**
2. **How to storage compressed gas**
3. **Fuel cell classification**
4. **Different parameters of fuel cell**
5. **Design of fuel cell**

**Course Outcomes**

| | |
|---|---|
| CO1 | Knowledge about hydrogen energy |
| CO2 | Able to get techniques to store compressed gas |
| CO3 | Knowledge about various types of fuel cell |
| CO4 | Find out the energy transferred and effect of various parameters |
| CO5 | Design of fuel cell |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Hydrogen as future fuel** **9 Hours** |
| **Importance of hydrogen as a future energy carrier –Thermodynamic and thermo physical properties-Chemical production of hydrogen–Steam reforming, thermal decomposition etc. - Purification - Desulfurization, removal of $CO_2$, CO, etc.- Electrolytic hydrogen production– Electrolyzer configurations -Thermolytic hydrogen production – Direct dissociation of water, chemical dissociation of water, photolytic hydrogen production, photo-biological hydrogen production** |
| **Unit II: Alternate fuels** **10 Hours** |
| **Compressed gas storage-Cryogenic liquid storage-Solid state storage–Adsorption and chemical compounds, Metal hydrides, hydride heat pumps and compressors** |
| **Unit III: principles of Fuel Cells** **10 hours** |
| **Fuel cells classification – operating temperatures, state of electrolyte, type of fuel, chemical nature of electrolyte. water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker.** |
| **Unit IV: Different Fuel cells** **7 hours** |
| **Polymer Electrolyte Membrane Fuel Cells (PEMFC) – Alkaline Fuel Cells (AFC)-Phosphoric Acid Fuel Cells (PAFC)- Direct Methanol Fuel Cells (DMFC)-Molten Carbonate Fuel Cells (MCFC)-Solid Oxide Fuel Cells (SOFC)** |
| **Unit V: Applications of Fuel cells** **9 hours** |
| **Stationary systems, automotive systems, portable fuel cells, small (less than 1 kW) fuel cells** |
| **Unit VI: Discussion on Latest Research Paper** **2 Hours** |
| **This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.** |

**Suggested Reading**

1. **Aldo V. da Rosa (2005), 'Fundamentals of Renewable Energy Processes', Elsevier Academic Press.**

2. Gregor Hogen Ed. (2003), 'Fuel Cell Technology Handbook', CRC Press.

| Name of The Course | Bio-Energy Technologies | | | |
|---|---|---|---|---|
| Course Code | MENE6027 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. Bio-energy and its mechanism
2. Different processes for production of bioenergy
3. To under different techniques and tools
4. Bioenergy production from different solid wastes
5. Energy Consumption and Cost - Environmental Aspects

**Course Outcomes**

| | |
|---|---|
| CO1 | Solid waste management by bioenergy |
| CO2 | Different processes used for biodegradation of solid waste and production of bioenergy |
| CO3 | The industrial applications of Bio-Energy. |
| CO4 | Environmental aspect of Bio-Energy |
| CO5 | Energy Consumption and Cost - Environmental Aspects |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| Unit I: Bio-energy 9 hours |
| Bio Energy - Bio Conversion Mechanism - Utilization of Photosynthate |
| Unit II: Bio-energy Extraction Principles 10 hours |
| Combustion, Pyrolysis, Gasification and Liguefaction - Biological Conversion - Methanol, Ethanol Production - Fermentation - Anaerobic Digestion Biodegradation and Biodegradability of Substrate - Hydrogen Generation from Algae – Biological Pathways |
| Unit III: Sources of Biomass 10 hours |
| Through Fermentation and Classification - Biomass Production from different Organic Wastes - Effect of Additives on Biogas Yield - Biogas production from Dry Dung Cakes |
| Unit IV: Bio-energy Systems 7 hours |
| Viability of Energy Production - Wood Gasifier System, Operation of Spark Ignition and Compression Ignition with Wood Gas. Operation and Maintenance |
| Unit V: Economics of Bio-energy 9 hours |
| Energy Effectives and Cost Effectiveness - History of Energy Consumption and Cost - Environmental Aspects of Bio-energy Conversion. |
| Unit VI: Discussion on Latest Research Paper 2 Hours |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. R. C. Maheswari (1997), 'Bio Energy for Rural Energisation' Concepts Publication.
2. Boyles (1984), 'Bio Energy Technology Thermodynamics and costs', Ellis Hoknood, Chichester.

| Name of The Course | Design of Wastewater Treatment & Disposal System |
|---|---|
| Course Code | MENE6034 |
| Prerequisite | - |

| | | | | | |
|---|---|---|---|---|---|
| Co-requisite | - | | | | |
| Anti-requisite | - | | | | |
| | | L | T | P | C |
| | | 3 | 0 | 0 | 3 |

**Course Objectives**

1. Need of advanced wastewater treatment
2. Process for removal nutrients
3. Physical and chemical methods
4. Economic value of environmental resources
5. Economics of biodiversity conservation

**Course Outcomes**

| | |
|---|---|
| CO1 | Know about the conventional treatment units and processes. |
| CO2 | Role of microorganisms in wastewater treatment. |
| CO3 | Nutrients removal by chemical and biological process |
| CO4 | Sludge treatment, handling and disposal. |
| CO5 | Wastewater reuse, recycling and disposal of treated effluents |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction to Nutrient in Wastewater** **9 Hours** |
| Effects of chemical constituents in wastewater, Need of advanced wastewater treatment, Basis of process selection and development of treatment flow sheets. Membrane Bio-Reactor (MBR) applications / Removal of residual suspended solids by micro screening. |
| **Unit II: Chemical Nutrient Removal** **10 Hours** |
| Sources and forms of Nitrogen (N) and Phosphorus (P), Processes for N and P removals. Conventional biological nitrification/ denitrification processes and their fundamentals. Sequencing Batch Reactor (SBR) and Simultaneous Nitrification – Denitrification (SND) processes for nitrogen removal. New processes for nitrogen removal: ANAMMOX, SHARON, CANON etc. Biological removal of Phosphorus- Process fundamentals and types of processes. Combined removal of N and P by biological methods. |
| **Unit III: Economic Value of Environmental Resources** **10 Hours** |
| Nitrogen removal by physical and chemical methods-Air stripping of ammonia/Break point Chlorination/Ion –exchange. Removal of phosphorus by chemical addition |
| **Unit IV: Concept of Total Economic Value** **7 Hours** |
| Economic value of environmental resources and environmental damage-Concept of Total Economic Value-Alternative approaches to valuation-Cost benefit analysis and discounting |
| **Unit V: Economics of bio-diversity Conservation** **9 Hours** |
| Economics of biodiversity conservation - Valuing individual environmental damage-Concept of Total Economic Value - Policy responses at national and international levels |
| **Unit VI: Discussion on Latest Research Paper** **2 Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. R. K. Turner, D. W. Pearceand, I. Bateman (1994), 'Environmental Economics: An

Elementary Introduction', Harvester Wheat sheaft, London.

2. D. W. Pearceand, R. K. Turner (1990), 'Economics of Natural Resources and the Environment', Harvester Wheat sheaf, London.

| Name of The Course | Urban Environmental Quality Management | | | |
|---|---|---|---|---|
| Course Code | MENE6035 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. Investigating the causes, consequences and degradation of environmental resources
2. Possible solutions to problems associated with degradation of environmental resources
3. Analyse the potential non-sustainability of certain types
4. Economic activities using economic analysis as a tool
5. To plan and to execute monitoring programmes

**Course Outcomes**

| | |
|---|---|
| CO1 | Have knowledge of the nature and effects of environmental pollutants and energies |
| CO2 | Have a detailed knowledge of the techniques involved in the efficient management of the environment |
| CO3 | Be able to measure and assess the effects of noise, air, water, terrestrial pollution and noise pollution on human activity and health |
| CO4 | Have an awareness of the need for integrated pollution control |
| CO5 | Have the skills to plan and to execute monitoring programmes for the detection and control of environmental pollutants, including water, air and noise terrestrial pollution |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Urbanization & Pollution** **9 Hours** |
| Consequences of urbanization, demand of resources by the public - Sources of Pollution to the urban environment: Status of pollution levels in major cities- Slum formation: Impact of slum on general quality of life on Urban elite – status of slum settlements in major cities |
| **Unit II: Air & Noise Pollution in Urban Environment** **10 Hours** |
| Air Pollution Sources: Nature of air pollution in urban environment due to human activities of industrialization, effect of air pollution on urban environment. Air pollution indices for assessment of status of urban air quality. Sources of noise pollution in urban areas, effect of noise pollution on urban environment, status of noise pollution in major cities. |
| **Unit III: Water and Land pollution in Urban Environment** **10 Hours** |
| Water Demands and Pollution in Urban areas: Nature of water pollutants and as similative capacity of natural Urban aquatic systems. Urban water quality indices- Sources of land pollution in urban areas: Impact of urban soil pollution on quality of living system– prediction of soil pollution indices. |
| **Unit IV: Management of Urban Environment Quality** **7 Hours** |
| Land use planning–traffic management. Safe municipal water supply and planning of safe municipal water supply and drainage system– solid waste management including disposal– abatement of noise pollution – Provision of zones – regulation |

| |
|---|
| **Unit V: Conservation and Disaster Management**<br>**9 Hours** |
| **Natural Conservation: Planning of urbanization on ecological basis, preservation and development of green recovery areas.- Urban Disaster Management: Management of Industrial explosions, landslides, earthquakes, Floods and Management of epidemics** |
| **Unit VI: Discussion on Latest Research Paper**<br>**2 Hours** |
| **This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.** |

**Suggested Reading**


1. Varshney, C.K. "Water Pollution and Management", Wiley Eastern Ltd., New Delhi, 1998
2. M. J. Suess & S. R. Craxford, "Manual on Urban Air Quality", WHO, Copenhagen


| **Name of The Course** | **Application of Bio-Technology in Environmental Engineering** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **MENE6038** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | **3** | **0** | **0** | **3** | |

**Course Objectives**

1. To introduce microbial and biotechnological concepts and theories.
2. To understand the biotechnological tools and their applications for environmental management.
3. To become familiar with the effective use of biotechnology in eco-sustainable waste management.
4. To understand various toxic chemicals
5. To understand various biotechnological technologies for environmental damages

**Course Outcomes**

| | |
|---|---|
| **CO1** | **To gain knowledge related to biology of microorganism** |
| **CO2** | **Environmental Management Strategies for Sustainable Development** |
| **CO3** | **Application of Microorganism in green technology** |
| **CO4** | **To address problems of toxic chemicals in environment** |
| **CO5** | **Gain knowledge on Biotechnological remedies for environmental damages** |
| **CO6** | **Discuss on latest research paper.** |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **nit I: Ecosystem**<br>**9 hours** |
| **Principles of biology-Cell structure, types, functions and communication during developments; Genes and development-gene expression and their regulation, regulation of cell and animal body development; Environment and Ecosystem and its components; Energy and bio-geo-chemical cycles; Microorganisms and Environment- microbes as functionary part of ecosystem, terrestrial and non-terrestrial environments, marine and freshwater environments; Ecological Niche;** |
| **Unit II: Human Development and Environment**<br>**10 hours** |
| **Historical Overview of Development and Pollution, Environmental Sustainability and Biodiversity; Biotechnology, Human and environment-concepts of biotechnology, its usefulness to humankind and global environment theories and philosophy; Contradiction between economic and environment; Environmental Management Strategies for Sustainable Development** |

| Unit III: Biotechnology Principles 10 hours |
|---|
| Microbial cell and enzyme technology-adapted microorganisms, bio-removal of nutrients, micro-algal biotechnology; Interaction of mixed microbial population and its applications in bio-processing of wastes, role of extracellular polymers, bioremediation of environmental problems; Concept of DNA technology, plasmid, mutation, genetically engineered microbial strains and applications of genetic engineering in environmental management. |
| **Unit IV: Toxic Chemicals 8 hours** |
| Problems of toxic chemicals-sources and categories, halogenated and non-halogenated chemicals, petroleum hydrocarbons, metals, human health effects caused by toxic chemical pollutions; Biodegradation of toxic pollutants, mechanisms of detoxification- oxidation reactions, dehalogenation, biotransformation of metals; Xenobiotic Compounds- types, sources and its hazards; Recalcitrance of xenobiotic compounds and leading factors; Biodegradation of xenobiotic compounds |
| **Unit V: Biotechnological remediation 9 hours** |
| Biotechnological remedies for environmental damages- decontamination of ground water systems, subsurface environment, reclamation concepts-bioremediation; Production of proteins, Biotransformation of waste into biofertilizers, biogas and electrical energy, affecting physical, chemical and microbiological factors, health risk, odor management, technological advances; Environmental effects and ethics of microbial technology; Biosafety; Clean Technology- concepts and applications in industrial process, clean synthesis; Farming as an engineering process. |
| **Unit VI: Discussion on Latest Research Paper 2 Hours** |
| **This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.** |

**Suggested Reading**


1. **Benefield L.D. and Randall, C.W. (1980). Biological process design for wastewater treatment. Prentice-Hall. N.J.**
2. **Pelczar, M.J., Chan ECS and Krieg NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.**


| Name of The Course | Mathematical Modelling in Environmental Engineering | | | |
|---|---|---|---|---|
| Course Code | MENE6040 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. **The scope and extent of mathematical modelling**
2. **The basic tenets of mathematical modelling and its application to environmental Processes**
3. **Mathematical modelling techniques**
4. **Plume Rise estimation Emissions inventories**
5. **Mathematical modelling methods applied to Global Environmental Problems**

**Course Outcomes**

| | |
|---|---|
| CO1 | Basic understanding of how mathematical models can be used to solve environmental problems |
| CO2 | Set up material balance models for conservative and non-conservative systems |
| CO3 | Formulate and solve Boundary value problems. |
| CO4 | Plume Rise estimation Emissions inventories |
| CO5 | Formulate, Set-up, and solve complex environmental Problems. |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Basic Environmental Processes** **9 Hours** |
| **The origins: Formation of the Physical Environment. The evolution of the Earth's atmosphere. Quantification of the Lapse Rate. The states of stability of the atmosphere Quantification of Wind circulation: Geo-strophic winds. Necessity of mathematical models. Concentration calculations and conversions in liquids and gases. Converting ppm into micro grammes/$m^3$ and vice-versa. Material Balance–Steady-state conservative systems-non-conservative pollutants. Mass-nergy flows and balances–specific examples in real-life environmental problems: Thermal pollution of a River** |
| **Unit II: Air Pollution Modelling** **10 Hours** |
| **The importance of Air Pollution modelling. Modelling the Atmospheric Boundary Layer–mixing length, and eddy diffusion. The formulation and solution of the Gaussian Plume Model. Gaussian Dispersion Coefficients. Plume Rise estimation Emissions inventories. Point, Line and Area Sources. Simple noise quality models : Models for Road way Noise** |
| **Unit III: Modelling of Sulphur Dioxide in atmosphere** **10 Hours** |
| **Modelling the mass transport of Sulphur Dioxide into falling raindrops. Reaction Pathways. Mass and Charge Balance. The convective diffusion equation. Normalisation of the CDE with reaction kinetics. Modelling the Homogeneous and Heterogeneous Pathways for Ozone depletion.** |
| **Unit IV: Modelling of Greenhouse gases** **7 Hours** |
| **Solar and Terrestrial Radiation. Quantifying the Green House Effect. A model for estimating the Equilibrium temperature of the Earth. Aerosol and cloud processes. The Basic tenets of Global Circulation Models for Weather Forecasting** |
| **Unit V: Modelling Biochemical Oxygen demand** **9 Hours** |
| **The unusual qualities of water. Modelling Biochemical Oxygen demand (BOD). Estimating the BOD Reaction Rate Constant. The effect of Oxygen-demanding wastes on rivers. A model for De-oxygenation. The Oxygen- sag curve. Solid waste modelling: Waste to Energy. Modelling the methane potential of discards.** |
| **Unit VI: Discussion on Latest Research Paper** **2 Hours** |
| **This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.** |

**Suggested Reading**


1. **Gilbert M., Master, 'Introduction to Environmental Engineering and Science', Prentice-Hall of India, New Delhi,1998**
2. Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous. 'Environmental Engineering'. McGraw-Hill Book Company, New York.1985


| **Name of The Course** | **Clean Development Mechanism & Green Technologies** | | | |
|---|---|---|---|---|
| **Course Code** | **MENE6041** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. The course is intended to teach the basics of CDM.
2. To become familiar with CDM processes.
3. To study CDM to address environmental problems
4. To study use of CDM in sustainable development
5. Case studies of various CDM of major projects

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Well aware of developments in Clean Development Mechanism.** |
| **CO2** | Understanding of Global Warming and Climatic changes. |
| **CO3** | **Develop ecologically sustainable production and industry through developing the potential of all fibres.** |
| **CO4** | **Develop environmentally and socially friendly alternatives** |
| **CO5** | **Many of the deleterious practices, processes and products currently in use** |
| **CO6** | **Discuss on latest research paper.** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Principle of Clean Development Mechanism 9 Hours** |
| **Introduction to Climate Change and Global Warming, International response to Climate Change & Global Warming** |
| **Unit II: Kyoto Protocol 10 Hours** |
| **Kyoto Protocol and its mechanism, objectives of Kyoto protocol and details of the agreement, Amendments of Kyoto Protocol.** |
| **Unit III: Clean Development Mechanism Process 10 Hours** |
| **Overview of Clean Development Mechanism, Administration and Participation, CDM, Project Cycle and Financing, Post Kyoto Negotiations and India.** |
| **Unit IV: Sustainable Development in CD 7 Hours** |
| **CDM, Sustainable Development and its Assessment, The CDM Market, Types of Major CDM Projects, Small Sectors and CDM, preparing CDM project design document (PDD) Course Project** |
| **Unit V: Case Studies on CDM Projects 9 Hours** |
| **Types of Major CDM Projects, Small Sectors and CDM, Detailed studies of CDM approved projects.** |
| **Unit VI: Discussion on Latest Research Paper 2 Hours** |
| **This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.** |

**Suggested Reading**


1. **White. I.D., Mottershead. D.N., Harrison .S.J, "Environmental Systems – an introductory text", Chapman and hall ,London,1998**
2. **David A. Gottfried, Sustainable Building Technical Manual., Public Technology Inc**


| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Environmental Ecology** | | | |
| **Course Code** | **MENE6042** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

**1. To establish Ecology's credibility in high environmental, ethical and quality standards of goods and services.**
**2. Access the market opportunity presented by the 'greenmarket'.**
**3. Raise consumer awareness and concern for environmental issues, and encourage their support for ecological values in consumer practices.**
**4. To develop affair and equitable means to link economic and environmental values**
**5. The development of mutually beneficial relationships with all segments of the community.**

**Course Outcomes**

| | |
|---|---|
| **CO1** | **Develop legal and economic structures** |
| **CO2** | **Able to provide reasonable return on investment, financial or personal effort, dividends, wages and so forth.** |

| | |
|---|---|
| CO3 | Develop ecologically sustainable production and industry through developing the potential of all fibres. |
| CO4 | Develop environmentally and socially friendly alternatives |
| CO5 | Many of the deleterious practices, processes and products currently in use |
| CO6 | Discuss on latest research paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Concepts of Ecology** **9 Hours** |
| Fundamentals of ecology, Natural ecosystems and their food chains, food webs, bioenergetics, biochemical cycles and ecological succession, deoxygeneation nutrient enrichment |
| **Unit II: Bio Diversity** **10 Hours** |
| Biological diversity and its importance, reduction in biological diversity by human activities, classes and general effects of physical and Biological interaction with pollutants, lethal and sub-lethal effects. |
| **Unit III: Ecosystem Ecology** **10 Hours** |
| Ecosystems responses to deoxygeneation nutrient enrichment, pesticides, hydrocarbons, metal and salts, thermal pollution, suspended solids and silt. |
| **Unit IV: Community Ecology** **7 Hours** |
| Principles of population and community ecology–concepts of systems and models–building and analysis of models–environmental systems, structures and interaction between coastal aeolian, glacial, fluvial, weathering, soil and detrital systems. |
| **Unit V: Integration Ecological Principles** **9 Hours.** |
| Integration of classical, agro and restoration ecological principle sand methods, Bio-monitoring and its role in the evaluation of aquatic ecosystem, rehabilitation of ecosystem through ecological engineering principles |
| **Unit VI: Discussion on Latest Research Paper** **2 Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**


1. Odum. E. P, "Fundamentals of ecology",W.B. Sanders, Philadelphia, 2002
2. **White. I.D., Mottershead. D.N., Harrison .S.J, "Environmental Systems – an introductory text", Chapman and hall, London, 1998.**


| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Environmental Economics, Legislation and Management** | | | | |
| **Course Code** | **MENE6046** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | **3** | **0** | **0** | **3** | |

**Course Objectives**

1. **To make the student investigating the causes, consequences**
2. **possible solutions to problems associated with degradation of environmental resources**
3. **Analyse the potential non-sustainability of certain types of economic activities using economic analysis as a tool.**
4. **The economic implications of alternative to pollution**
5. **Alternative methods for valuing environmental resources and environmental damage**

**Course Outcomes**

| | |
|---|---|
| CO1 | The economic significance and the economic causes of environmental degradation, including loss of diversity |
| CO2 | The extent to which market based mechanisms might provide a solution to the |

| | |
|---|---|
| | **environmental degradation problem in the absence of overt intervention** |
| **CO3** | **The economic implications of alternative 'intervention' approaches to pollution management, including the use of charges, subsidies and market permits.** |
| **CO4** | **Alternative methods for valuing environmental resources and environmental damage** |
| **CO5** | **The economic consequences of policy instrument for biodiversity conservation** |
| **CO6** | **Discuss on latest research paper.** |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction to Sustainable Development** **9 Hours** |
| **Introduction to sustainable development - Economy-Environment inter-linkages - Meaning of sustainable development- Limits to growth and the environmental Kuznets curve –The sustainability debate- Issues of energy and the economics of energy – Non-renewable energy, scarcity, optimal resources, back stop technology, property research, externalities, and the conversion of uncertainty** |
| **Unit II: Economic Significance** **10 Hours** |
| **Economic significance and causes of environmental degradation - The concepts of policy failure, externality and market failure - Economic analysis of environmental degradation - Equi-marginal principle.** |
| **Unit III: Economics of Pollution** **10 Hours** |
| **Economics of Pollution - Economics of optimal pollution, regulation, monitoring and enforcement - Managing pollution using existing markets: Bargaining solutions - Managing pollution through market intervention: Taxes, subsidies and permits.** |
| **Unit IV: Economic Value of Environmental Resources** **7 Hours** |
| **Economic value of environmental resources and environmental damage-Concept of Total Economic Value-Alternative approaches to valuation-Cost benefit analysis and discounting** |
| **Unit V: Economics of bio-diversity Conservation** **9 Hours** |
| **Economics of biodiversity conservation - Valuing individual species and diversity of species - Policy responses at national and international levels** |
| **Unit VI: Discussion on Latest Research Paper** **2 Hours** |
| **This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class.** |

**Suggested Reading**

1. D.W. Pearce and R.K. Turner (1990), Economics of Natural Resources and the Environment, Harvester Wheatsheaf, London.
2. R.K.Turner, D.W.Pearce and I.Bateman (1994), Environmental Economics:AnElementaryIntroduction, Harvester Wheatsheaft, London.

GALGOTIAS UNIVERSITY
(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

**Program:** MTech in Structural Engineering

**Scheme: 2019-2020**

**Vision**

To be a Centre of Excellence for imparting high end research and technical education in Civil Engineering producing socially aware professionals to provide sustainable solutions to global community.

**Mission**

**M1:** To impart quality education and mould technically sound, ethically responsible professionals in the field of Civil Engineering.

**M2:** Collaborate with industry and society to design a curriculum based on the changing needs of stakeholders and provide excellence in delivery and assessment.

**M3:** Establish state-of-the-art facilities for world class education and research.

**M4:** To mentor students in pursuit of higher education, entrepreneurship and global professionalism.

**PEOs**

**PEO1:** Graduates shall attain state of the art knowledge in the different streams of Civil Engineering and be trained for playing the role of competent Civil Engineer in multidisciplinary projects.

**PEO2:** Graduates shall be capable of pursuing productive careers in private and government organizations at the national and international level and to become successful entrepreneurs.

**PEO3:** Graduates shall display a high sense of social responsibility and ethical thinking and develop sustainable engineering solutions.

**PSOs**

**PSO1:** Develop the ability to implement emerging techniques to plan, analyze, design, execute, manage, maintain and rehabilitate systems and processes in structural engineering.

**PSO2:** Excel in research, innovation, design, problem solving using different softwares and artificial intelligence and develop an ability to interact and work seamlessly in multidisciplinary environment.

**POs**

**PO1:** Apply the knowledge of Mathematics, Science, and Engineering fundamentals, and an engineering specialization to solution of complex engineering problems (Engineering Knowledge)

**PO2:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (Problem analysis)

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

**PO4:** Use research based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions (Conduct investigations of complex problems)

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

**PO6:** Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice (The engineer and society)

**PO7:** Understand the impact of the professional engineering solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments (Environment and sustainability)

**PO8:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice (Ethics)

**PO9:** Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings (Individual and team work)

**PO10:** Communicate effectively on complex engineering activities with the engineering community and with society at large such as being able to comprehend and write effective reports and design documentation, make effective oral presentations, and give and receive clear instructions (Communication)

**PO11:** Demonstrate knowledge and understanding of engineering management principles and apply those to one's own work as a member and leader of a team to manage projects in multidisciplinary environments (Project management and finance)

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

**Curriculum**

| Semester 1 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | CENG5001 | Professional and Communication Skills | 0 | 0 | 4 | 2 | 50 | - | 50 |
| 2 | MATH5001 | Advanced Numerical and Statistical Methods | 3 | 1 | 0 | 4 | 20 | 30 | 50 |
| 3 | MSTR5001 | Structural Dynamics | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | MSTR5002 | Matrix Methods of Structural Analysis | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | MSTR5003 | Advanced Concrete Technology | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | MSTR5004 | Design of Concrete Structural Systems | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 7 | MSTR5005 | Matrix methods of Structural Analysis Lab (STAAD PRO) | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 8 | MSTR5006 | Design of Concrete and Structural Systems Lab (STAAD PRO) | 0 | 0 | 2 | 1 | 50 | - | 50 |
| | | **Total Credit** | | | | **20** | | | |
| **Semester II** | | | | | | | | | |
| **Sl. No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | MSTR6001 | Finite Element Analysis | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | MSTR6002 | Theory of Elasticity and Plasticity | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | MSTR6003 | Limit State Design of Steel Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | | Elective – 1 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | | Elective – 2 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | | Elective – 3 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 7 | MSTR6004 | Structural Engineering lab (CASTING) | 0 | 0 | 2 | 1 | 50 | - | 50 |
| 8 | MSTR6005 | Finite Element Analysis Lab (STAAD PRO) | 0 | 0 | 2 | 1 | 50 | - | 50 |
| | | **Total Credit** | | | | **20** | | | |
| **Semester III** | | | | | | | | | |
| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | MSTR7001 | Application of Numerical Methods in Structural Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | | Elective – 4 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | | Elective – 5 | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | MSTR7002 | Seminar (or)Mini Project | - - | - - | 2 | 1 | 50 | - | 50 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | MSTR7003 | Comprehensive Examination | - | - | - | 2 | 50 | - | 50 |
| 6 | MSTR7004 | Project (Phase I) | 0 | 0 | 0 | 5 | 50 | - | 50 |
| | | **Total Credit** | | | | **17** | | | |
| **Semester IV** | | | | | | | | | |
| **Sl No** | **Course Code** | **Name of the Course** | | | | | **Assessment Pattern** | | |
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | MSTR8001 | Project (Phase II) | 0 | 0 | 0 | 15 | 50 | - | 50 |
| | | **Total Credit** | | | | **15** | | | |

**List of Electives (Total Credits to be earned = 15)**

| **Sl No** | **Course Code** | **Name of the Electives** | | | | | **Assessment Pattern** | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | **L** | **T** | **P** | **C** | **IA** | **MTE** | **ETE** |
| 1 | MSTR6010 | Advanced Foundation Engineering | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 2 | MSTR6011 | Design of Concrete Bridges | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 3 | MSTR6012 | Design of Industrial Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 4 | MSTR6013 | Earthquake Resistant Design | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 5 | MSTR6014 | Design of Tall Buildings | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 6 | MSTR6015 | Energy Efficient Buildings | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 7 | MSTR6016 | Environmental Engineering Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 8 | MSTR6017 | Experimental Stress Analysis | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 9 | MSTR6018 | Machine Foundations | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 10 | MSTR6019 | Maintenance & Rehabilitation of Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 11 | MSTR6020 | Theory and Design of Plates & Shells | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 12 | MSTR6021 | Off Shore Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 13 | MSTR6022 | Prefabricated Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 14 | MSTR6023 | Pre-stressed Concrete Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 15 | MSTR6024 | Soil Structure Interaction | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 16 | MSTR6025 | Stability of Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 17 | MSTR6026 | Structural Optimization | 3 | 0 | 0 | 3 | 20 | 30 | 50 |
| 18 | MSTR6027 | Composite Structures | 3 | 0 | 0 | 3 | 20 | 30 | 50 |

**Detailed Syllabus**

| Name of The Course | Structural Dynamics | | | |
|---|---|---|---|---|
| Course Code | MSTR5001 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To find the behaviour of structures subjected to dynamic loads such as wind, earthquake and blast loads.
2. To study different dynamic analysis procedures for calculating response of structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Solve the problems on single degree of freedom system. |
| **CO2** | Understand the concept of harmonic loading and impulse loading and the related analysis procedures. |
| **CO3** | Understand the concept of multi degree of freedom system. |
| **CO4** | Evaluate the mode shapes for different structures. |
| **CO5** | Know the orthogonality condition |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: SDOF Systems** **8 Lecture Hours** |
|---|
| Single Degree of Freedom System - Introduction - Alembert's principle - Mathematical models for SDOF systems - Free vibration - Damped and undamped - Critical damping - Logarithmic decrement. |
| **Unit II:Harmonic and Impulse Loading** **8 Lecture Hours** |
| Response to Harmonic Loading and Impulse Loading - Analysis of undamped system - damped system - general dynamic loading. |
| **Unit III: Vibration Analysis** **8 Lecture Hours** |
| Vibration Analysis - Rayleigh's method - Approximate Analysis - Improved Rayleigh method. |
| **Unit IV: MDOF System** **8 Lecture Hours** |
| Multi degree of Freedom System - Evaluation of structural property matrices - Mode shape - Orthogonality conditions - Undamped and damped system - Mode superposition method. |
| **Unit V: Continuous Systems** **8 Lecture Hours** |
| Continuous Systems - Differential equation of motion - Transverse vibration of linearly elastic beams - Analysis of undamped free vibration of simply supported and cantilever beams - Orthogonality condition. |

**Suggested Reading**

1. Mario Paz, (2004), Structural Dynamics - Theory and Computation, Second Edition, CBS Publishers, ISBN-13: 9788123909783.
2. J. Humar, (2012), Dynamics of Structures, Third Edition, CRC Press, ISBN- 13: 9780415620864.
3. Anil K. Chopra, (2003), Dynamics of Structures - Theory and Applications to Earthquake Engineering, Third Edition, Pearson India, ISBN-13: 9788131713297.

| Name of The Course | Matrix Methods of Structural Analysis | | | |
|---|---|---|---|---|
| Course Code | MSTR5002 | | | |
| Prerequisite | Structural Analysis | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. The course is intended to teach the basic concepts of indeterminate structures, static indeterminacy and kinematic indeterminacy.
2. Different matrix methods will be taught and their uses will be explained in the class.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Solve different structures by flexibility matrix method and stiffness matrix method. |
| **CO2** | Visualize and analyze plane trusses and plane frames. |
| **CO3** | Understand the effect of settlement of supports. |
| **CO4** | Analyze space trusses and plane frames. |
| **CO5** | Solve any problem on grid. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

On completion of this course, the students will be able to

| |
|---|
| **Unit I: Introduction to flexibility matrix and stiffness matrix.** **8 Lecture Hours** |
| Concept of static indeterminacy and kinematic indeterminacy – concept of flexibility matrix and stiffness matrix – properties of matrices – coordinate system – solution of simple problems – derivation of stiffness matrix of beam element from strain energy. |
| **Unit II: Analysis of plane structures by flexibility matrix method** **8 Lecture Hours** |
| Analysis of continuous beam, plane truss and plane frame by flexibility matrix method – Internal forces due to thermal expansion and lack of fit – effect of settlement of supports. |
| **Unit III: Analysis of plane structures by stiffness matrix method** **8 Lecture Hours** |
| Analysis of continuous beam, plane truss and plane frame by stiffness matrix method – Internal forces due to thermal expansion and lack of fit – effect of settlement of supports |
| **Unit IV: Space truss** **8 Lecture Hours** |
| Analysis of space truss by flexibility matrix method and stiffness matrix method. |
| **Unit V: Analysis of space structures by stiffness matrix method** **8 Lecture Hours** |
| Analysis of space frame and grid structures by stiffness matrix method |

**Suggested Reading**

1. Pundit G.S. & Gupta S.P., (2008), Structural Analysis (A matrix approach), Second Edition, Tata McGraw Hill Education, ISBN-13: 9780070667358.
2. J. S. Przemieniecki, (1985), Theory of Matrix Structural Analysis, New Edition, Dover Publication, ISBN-13: 97804866494.
3. Richard B. Nelson, Lewis P. Felton, (1997), Matrix Structural Analysis, John Wiley & Sons, Imported Edition, ISBN-13: 9780471123248.

| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Advanced Concrete Technology** | | | |
| **Course Code** | **MSTR5003** | | | |
| **Prerequisite** | **Concrete Technology** | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This course mainly aims to develop the knowledge about properties of cement concrete and importance of admixtures in concrete.
2. To make the students to understand Mix Design Method.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the various materials used in concrete and admixtures |
| **CO2** | Do the Mix design by different methods. |
| **CO3** | Get a thorough knowledge of various types of cement, aggregates and properties of special concrete |
| **CO4** | Know the different procedures for testing concrete. |
| **CO5** | Understand different types of special concrete. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Material, reinforcement and admixtures** **8 Lecture Hours** |

| |
|---|
| Materials - Concrete materials - Reinforcements and admixtures. |
| **Unit II: Mix design** **8 Lecture Hours** |
| Mix Design – Specifications - Design of concrete mixes by IS code method - ACI method - Road Note No: 4 methods – High strength concrete |
| **Unit III: Modern trends in concrete** **8 Lecture Hours** |
| Behaviour of Concrete - Modern trends in concrete manufacture and placement techniques- Behaviour of fresh concrete and hardened concrete - Resistance to static and dynamic loads. |
| **Unit IV: Concrete testing** **8 Lecture Hours** |
| Testing of Concrete - Non-destructive testing and quality control – Durability - Corrosion protection and fire resistant. |
| **Unit V: Special concrete** **8 Lecture Hours** |
| Special Concrete - Pre-cast concrete - Light weight concrete - Under water concrete – Pump concrete - Polymer concrete - Composites and fibre reinforced concrete. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Shetty. M. S., (2008), Concrete Technology, Seventh Edition, S. Chand & Company Ltd.ISBN-13: 9788121900034.

2. M. L. Gambhir, (2013), Concrete Technology, Fifth Edition, McGraw Hill Education India Pvt. Ltd., ISBN-13: 9781259062551.

3.A. R. Santha Kumar, (2006), Concrete Technology, First Edition, Oxford University Press, ISBN-13: 9780195671537.

| **Name of The Course** | **Design of Concrete Structural Systems** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR5004** | | | |
| **Prerequisite** | **Design of Concrete Structures** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject is intended to teach the concept of advanced concrete design.
2. The practical aspects of various designs of structure will be explained in the classes

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand rotation capacity of a RC section and moment curvature relationship. |
| **CO2** | Analyse and design deep beams. |
| **CO3** | Design flat slabs. |
| **CO4** | Understand the concept of designing slender columns and shear walls. |
| **CO5** | Design different types of water tanks |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Limit state design of beams** **8 Lecture Hours** |
| Limit state analysis and design of beams in flexure - Behaviour of reinforced concrete - Members in bending - Plastic hinge – Rotation capacity – Factors affecting rotation capacity – of a section –Plastic moment – Moment curvature relationship – Redistribution of moments. |
| **Unit II: Deep beams** **8 Lecture Hours** |
| Limit state design of deep beams |
| **Unit III: Flat Slabs** **8 Lecture Hours** |
| Design of Flat Slabs using BIS 456 |
| **Unit IV: Columns and shear walls** **8 Lecture Hours** |
| Design of slender columns subjected to combined bending moment and axial force using SP: 16, Design of shear walls, Ductile detailing. |
| **Unit V: Design of Water Tanks** |

| 8 Lecture Hours |
|---|
| Types of water tanks, Design of underground rectangular water tanks, Design of overhead water tank (Intze type tank), Design of staging. |

**Suggested Reading**


1. P. C. Varghese, (2009), Advanced Reinforced Concrete Design, Second Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120327870.
2. M. L. Gambhir, (2009), Design of Reinforced Concrete Structures, First Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120331938.
3. P. Dayaratnam, (2011), Design of Reinforced Concrete Structures, Fourth Edition, Oxford & IBH – Pubs Company, ISBN-13: 9788120414198.
4. B. C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, (2006), R. C. C. Designs, Laxmi Publication (P) Ltd., ISBN-13: 9788131809426.


| **Name of The Course** | **Finite Element Analysis** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6001** | | | |
| **Prerequisite** | **Matrix Methods of Structural Analysis** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. The course is intended to teach the basic concepts of finite element analysis.
2. The practical application of finite element method and their advantages and disadvantages will be explained in the class.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Carry out finite element analysis of beam. |
| **CO2** | Understand the concept of displacement polynomials |
| **CO3** | Analyse plane trusses, plane frames and grids. |
| **CO4** | Calculate strain-displacement matrix and stress-strain matrix for plane stress elements. |
| **CO5** | Know the concepts of isoparametric elements. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| **Unit I: Introduction to FEM** **8 Lecture Hours** |
|---|
| Introduction - Background - General description of the method – Analysis procedure - Stress and strain vectors – Stain displacement equations – Linear constitutive equations – Overall stiffness matrix – Overall load matrix - Analysis of beams. |
| **Unit II: Displacement models** **8 Lecture Hours** |
| Theory of Finite Element - Concept of an element - Various elements shapes - Displacement polynomials - Convergence requirements - Shape functions - Element strains and stresses - Direct formulation of element stiffness matrix for beam element and plane truss element |
| **Unit III: Analysis of structures by FEM** **8 Lecture Hours** |
| Overall Problems - Discretization of a body or structure - Minimization of band width - Construction of stiffness matrix and loads for the assemblage - Boundary conditions - Analysis of plane truss, space truss, plane frame and grid. |
| **Unit IV: Plane stress and plane strain** **8 Lecture Hours** |
| Plane stress - Plane strain - CST, LST & QST elements – Rectangular element - solutions of problems. |
| **Unit V: Isoparametric elements** **8 Lecture Hours** |
| Natural Coordinate - Isoparametric Formulation - Natural coordinates (area and volume) - Isoparametric Bar element - Plane bilinear isoparametric element - Plane stress element - Quadratic plane stress elements - Application of Gauss Quadrature formulation. |

**Suggested Reading**


1. C. S. Krishnamoorthy, (2008), Finite Element Analysis, Second Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 978007462100.
2. Cook R. D., Malkas D. S. &Plesha M. E, (2008), Concepts and applications of Finite element analysis, Fourth Edition, Wiley India Pvt. Ltd., ISBN-13: 9788126513369.

3. Reddy, (2005), An Intro. To The Finite Element Methods, Third Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 9780070607415.

| Name of The Course | Theory of Elasticity and Plasticity | | | |
|---|---|---|---|---|
| Course Code | MSTR6002 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. This subject is taught to impart knowledge on theory of elasticity and plasticity.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| CO1 | Analyse the stresses and strains for two dimensional and three dimensional elements. |
| CO2 | Understand the equilibrium and compatibility conditions. |
| CO3 | Know the concept of Prandle's membrane analogy. |
| CO4 | Solve the problems on Torsion for different shaped bars. |
| CO5 | Understand the concept of plasticity. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Stresses and strains** **8 Lecture Hours** |
| Analysis of Stress and Strain - Elasticity approach – Definition and notation of stress – Components of stress and strain – Generalized Hooke's law -Two dimensional Problems in Cartesian Coordinates - Plane stress and plain strain problems with practical examples - Equations of equilibrium and compatibility conditions in Cartesian coordinates – Airy's stress function - Bending of simply supported beams. |
| **Unit II: Axi-symmertic problems** **8 Lecture Hours** |
| Two dimensional Problems in Polar Coordinates - Equations of equilibrium and compatibility conditions in polar coordinates – Axi-symmetrical problems - Thick cylinder under uniform pressure - Circular arc beams subjected to pure bending |
| **Unit III: Prandle's membrane analogy** **8 Lecture Hours** |
| Principal stresses and strains for three dimensional element – Equations of equilibrium and compatibility conditions for 3D problems in Cartesian co-ordinates - Transformation of stresses and strains. |
| **Unit IV: Torsion** **8 Lecture Hours** |
| Torsion - Torsion of various shaped bars - Pure torsion of prismatic bars - Prandtle's membrane analogy - Torsion of thin walled tubes and hollow shafts. |
| **Unit V: Introduction to plasticity** **8 Lecture Hours** |
| Introduction to plasticity – Stress – Strain diagram – Plastic analysis – Yield criteria – St. Venant's theory – Von Mises criterion – Plastic work – Strain hardening. |

**Suggested Reading**

1. Timoshenko and Goodier, (1970), Theory of Elasticity, Third Edition, McGraw Hill
Professional, ISBN-13: 9780070858053.
2. Srinath, (2002), Advanced Mechanics of Solids, Third Edition, Tata McGraw Hill Pvt. Ltd., ISBN-13: 9780070139886.
3. D. Peric, E. A. de Souza Neto& D. R. J. Owen, (2011), Computational Methods for
Plasticity, Wiley, ISBN-13: 9781119964544.

| Name of The Course | Limit State Design of Steel Structures | | | |
|---|---|---|---|---|
| Course Code | MSTR6003 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To know how to design and use the different types of steel structural elements.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Design different types of connections. |
| **CO2** | Design members for pitched roof truss, bracings and purlins. |
| **CO3** | Understand the design of plate girders and gantry girders. |
| **CO4** | Design chimney. |
| **CO5** | Understand the concept of plastic analysis. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Eccentric and Moment Connections** **8 Lecture Hours** |
| Different types of beam-column connections – Design of rigid and semi rigid connection. |
| **Unit II: Industrial Buildings** **8 Lecture Hours** |
| Roof Trusses - Calculation of dead load, live load and wind load - Design of joints – Design of members for pitched roof truss – Bracings – Design of Purlins. |
| **Unit III: Plate Girder and Gantry Girder** **8 Lecture Hours** |
| Elements of plate girders – Shear strength of web - Design of plate girders - Curtailment of flange plates – Design of stiffeners – Design of gantry girder. |
| **Unit IV: Chimney** **8 Lecture Hours** |
| Calculation of wind load and seismic load, Design of chimney, Design of foundation of chimney |
| **Unit V: Plastic Analysis** **8 Lecture Hours** |
| Plastic Analysis of Structures – Introduction - Shape factors – Mechanisms - Plastic hinge - Analysis of beams and portal frames - Design of continuous beams. |

Suggested Reading

1. Dayarathnam. P., (1996), Design of Steel Structures, Second Edition, S. Chand and Publishers, ISBN-13: 0788121923200.

2. Duggal S. K., (2014), Limit State Design of Steel Structures, Second Edition, McGraw Hill, ISBN-13: 9789351343509.

3. Ramchandra, VirendraGehlot, (2010), Limit State Design of Steel Structures: Based on IS: 800-2007 IN S. I. Units, Scientific Publishers, ISBN-13: 9788172336141.

| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Application of Numerical Methods in Structural Engineering** | | | | |
| **Course Code** | **MSTR7001** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | **3** | **0** | **0** | **3** | |

**Course Objectives**

1. This subject is taught to impart knowledge on numerical methods in structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Solve the linear simultaneous equations |
| **CO2** | Use the Finite difference method. |
| **CO3** | Calculate bending moment, slope and deflection for beams using Simpson's rule and Gauss Quadrature method |
| **CO4** | Understand the concept of finite strip method of analysis of plates. |
| **CO5** | Evaluate the eigen values and eigen vectors for stability problems |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Simultaneous equations** **8 Lecture Hours** |
| Solution of linear simultaneous equations – Gauss elimination method, Gauss-Jordan method, Gauss-Siedal method - Banded - Semi-banded matrix– Skyline technique. |
| **Unit II: Finite difference method** **8 Lecture Hours** |

| |
|---|
| Finite difference method – Solution of simultaneous equations – Bending moment - Slope and deflection in beams - Membrane analogy using finite difference method for slabs-slope and deflection of slabs. |
| **Unit III: Numerical methods** **8 Lecture Hours** |
| Numerical Methods – Numerical integration (Trapezoidal and Simpson's rule) for determining shear, moment and deflection in beams– Gauss Quadrature formula. |
| **Unit IV: Finite Strip method for analysis of plates** **8 Lecture Hours** |
| Finite Strip Method – Shape Functions – Strain - Displacement Relationship – Strip Stiffness Matrix – Load Matrix – Solution of Problems. |
| **Unit V: Eigen values and Eigen Vectors** **8 Lecture Hours** |
| Mass Matrix - Stiffness matrix - Dynamic Analysis - Eigen values & Eigen Vectors |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. N. Krishnaraju& K. U. Muthu, (2008), Numerical Methods for Engineering problems, Second Edition, Macmillan India Ltd., ISBN-13: 9780333924242.

2. Jain M. K., Iyengar, R. K. & Jain R. K. (2004), Numerical Methods: Problems and Solutions, Second Edition, New Age International (P) Ltd., ISBN-13: 9788122415346.

3. Klaus-Jsrgan Bathe, (2008), Finite Element Procedures, First Edition, Prentice Hall of India, ISBN-13: 9788120310759.

| **Name of The Course** | **Matrix Methods of Structural Analysis Lab (STAAD PRO)** | | | | |
|---|---|---|---|---|---|
| **Course Code** | **MSTR5005** | | | | |
| **Prerequisite** | **MSTR5002** | | | | |
| **Co-requisite** | **-** | | | | |
| **Anti-requisite** | **-** | | | | |
| | **L** | **T** | **P** | **C** | |
| | **0** | **0** | **2** | **1** | |

**Course Objectives**

1. This subject is taught to impart knowledge on Matrix Methods of Structural Analysis using STAAD-PRO software package.
2. The practical application of the STAAD-PRO software package will be taught.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Use STAAD PRO software package for analysis of different types of structures. |
| **CO2** | Use STAAD PRO software package for drawing shear force diagram and bending moment diagram |
| **CO3** | Understand the behaviour of different types of structures. |
| **CO4** | Understand the deflected shape of different types of structures. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| **50** | **-** | **50** | **100** |

**Course Content:**

**List of Experiments:**

1.Analysis of propped cantilever beam
2. Analysis of two span continuous beams
3. Analysis of statically determinate plane truss
4. Analysis of statically indeterminate plane truss
5. Analysis of kinematically indeterminate plane truss
6. Analysis of one bay – one storey plane frame
7. Analysis of multi bay – multi storied plane frame
8. Analysis of space truss
9. Analysis of grid
10. Analysis of space frame

**Suggested Reading**

1. STAAD Pro details from Internet
2. Videos form Internet.

| **Name of The Course** | **Design of Concrete and Structural Systems lab (STAAD PRO)** |
|---|---|
| **Course Code** | **MSTR5006** |
| **Prerequisite** | **MSTR5004** |
| **Co-requisite** | **-** |

| Anti-requisite | - | | | |
|---|---|---|---|---|
| | L | T | P | C |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. This subject is taught to impart knowledge on design of concrete structures using STAAD-PRO software package.
2. The practical application of the STAAD-PRO software package will be taught.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Design continuous beams |
| **CO2** | Design deep beams |
| **CO3** | Design columns |
| **CO4** | Design shear walls |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

**List of Experiments:**

1.Design of Continuous beams
2. Design of Deep beams
3. Design of Columns
4. Design of Shear walls

**Suggested Reading**

1. STAAD Pro details from Internet
2. Videos form Internet.

| Name of The Course | Structural Engineering Laboratory (CASTING) | | | |
|---|---|---|---|---|
| Course Code | MSTR6004 | | | |
| Prerequisite | MSTR5003 | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To teach students different types of testing of concrete structures.
2. To enable the students to know the behaviour of RCC structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Design concrete mix for particular grade of concrete |
| **CO2** | Test concrete beams for various loading conditions |
| **CO3** | Perform non-destructive testing |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

**List of Experiments:**

1. To determine the compressive strength of fibre reinforced concrete by testing cubes specimen.
2. Casting and testing of simply supported RCC beams for flexural failure.
3. Casting and testing of simply supported RCC beams for shear failure.
4. To determine tensile strength on a steel reinforcement bar.
5. To determine shear strength of steel bar under double shear.
6. To conduct bending test of I-section steel beam.
7. To conduct bending test of steel channel section.
8. To study rebound hammer test on concrete blocks.
9. To study ultra sonic pulse velocity test

**Suggested Reading**

1. Shetty. M. S., (2008), Concrete Technology, Seventh Edition, S. Chand & Company Ltd.ISBN-13: 9788121900034.
2. M. L. Gambhir, (2013), Concrete Technology, Fifth Edition, McGraw Hill Education India Pvt. Ltd., ISBN-13: 9781259062551.
3. Videos form Internet.

| Name of The Course | Finite Element Analysis Lab (STAAD PRO) |
|---|---|
| Course Code | MSTR6005 |
| Prerequisite | MSTR5005 |
| Co-requisite | - |
| Anti-requisite | - |

| | L | T | P | C |
|---|---|---|---|---|
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To teach the students to understand the finite element analysis of different types of structures.
2. To enable the students to know the details of the STAAD-PRO software package.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the use of STAAD-PRO software package for finite element analysis of different types of structures. |
| **CO2** | Use STAAD-PRO software package for drawing shear force diagram and bending moment diagram. |
| **CO3** | Understand the behaviour of different types of structures. |
| **CO4** | Understand the deflected shape of different types of structures. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Course Content:**

**List of Experiments:**

1. Analysis of three span continuous beams.
2. Analysis of propped cantilever beam.
3. Analysis of statically determinate plane truss.
4. Analysis of statically indeterminate plane truss.
5. Analysis of one bay – one storey plane frame.
6. Analysis of two bays – one storey plane frame.
7. Analysis of a 2-D building frame subjected to dead load, live load and seismic load.
8. Analysis of grid.

**Suggested Reading**

1. STAAD Pro details from Internet
2. Videos form Internet.

| | |
|---|---|
| **Name of The Course** | **Seminar** |
| **Course Code** | **MSTR7002** |
| **Prerequisite** | - |
| **Co-requisite** | - |
| **Anti-requisite** | - |

| | L | T | P | C |
|---|---|---|---|---|
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analyze the various topologies for the selected topic of interest.
4. To conclude the advantages, drawbacks and future scopes of the technique.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Get familiarity with the recently advanced techniques. |
| **CO2** | Get detailed information about the topic of interest |
| **CO3** | Know how to do literature survey. |
| **CO4** | Develop the interest in different research areas of Structures. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Suggested Reading**

1. Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal
2. Depending upon their area of interest, students may choose any reference book of relevant field.

| | |
|---|---|
| **Name of The Course** | **Mini Project** |
| **Course Code** | **MSTR7002** |
| **Prerequisite** | - |
| **Co-requisite** | - |
| **Anti-requisite** | - |

| | L | T | P | C |
|---|---|---|---|---|
| | 0 | 0 | 2 | 1 |

**Course Objectives**

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analyze the various topologies for the selected topic of interest.
4. To conclude the advantages, drawbacks and future scopes of the technique.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Get familiarity with the recently advanced techniques |
| **CO2** | Get detailed information about the topic of interest. |
| **CO3** | Know how to do literature survey |
| **CO4** | Develop the interest in different research areas of Structures. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **50** | **-** | **50** | **100** |

**Suggested Reading**

1. Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal.
2. Depending upon their area of interest, students may choose any reference book of relevant field.

| **Name of The Course** | **Project (Phase I)** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR7004** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **0** | **0** | **0** | **5** |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to civil engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Submit a project synopsis comprising of the application and feasibility of the project |
| **CO2** | Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability. |
| **CO3** | Work and communicate efficiently in multidisciplinary teams. |
| **CO4** | Identify, formulate, and solve engineering problems. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **50** | **-** | **50** | **100** |

**Suggested Reading**

1. Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal.
2. Depending upon their area of interest, students may choose any reference book of relevant field.

| **Name of The Course** | **Project (Phase II)** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR8001** | | | |
| **Prerequisite** | **MSTR7004** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **0** | **0** | **0** | **15** |

**Course Objectives**

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to civil engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Submit a project synopsis comprising of the application and feasibility of the project. |
| **CO2** | Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care, safety and sustainability. |
| **CO3** | Work and communicate efficiently in multidisciplinary teams. |
| **CO4** | Identify, formulate, and solve engineering problems. |
| **CO5** | Develop an understanding of professional and ethical responsibility. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 50 | - | 50 | 100 |

**Suggested Reading**

1. Depending upon their area of interest, students may choose any text book of relevant field or any article from Journal
2. Depending upon their area of interest, students may choose any reference book of relevant field Depending upon their area of interest, students may choose any reference book of relevant field.

| | |
|---|---|
| **Name of The Course** | **Advanced Foundation Engineering** |
| **Course Code** | **MSTR6010** |
| **Prerequisite** | - |
| **Co-requisite** | - |
| **Anti-requisite** | - |

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objectives**

1. This subject is taught to impart the knowledge in the area of analysis and design of foundations and earth retaining structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the concepts of shallow foundations. |
| **CO2** | Design the retaining walls and sheet piles. |
| **CO3** | Know the concept of pile group |
| **CO4** | Design pile foundation |
| **CO5** | Know the types well foundations. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Shallow foundation** **8 Lecture Hours** |
| Shallow Foundations – Spread footings – Contact pressure – Structural design of individual footings – Pedestals – Combined footings (Rectangular and trapezoidal) – Eccentrically loaded footings – Mat foundations |
| **Unit II: Deep foundation** **8 Lecture Hours** |
| Pile Foundations – Types of piles – Static and dynamic pile formula – Pile groups – Efficiency of pile group |
| **Unit III: Pile foundations** **8 Lecture Hours** |
| Settlement of piles – Batter piles – Analysis of pile groups – Structural design of piles and pile caps |
| **Unit IV: Retaining structures** **8 Lecture Hours** |
| Retaining Structures – Stability of walls – Design of cantilever and counter fort walls – Design of gravity walls – Coffer dams – Braced coffer dams – Stability of bottom excavation – Anchorage – Walls and tie rods |
| **Unit V: Well foundations** |

| 8 Lecture Hours |
|---|
| Well Foundations – Types of wells or caissons – Components – Shapes of wells – Forces acting – Construction– Design of drilled caissons |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Gopal Ranjan and A S R Rao (2000), Basic and Applied Soil Mechanics, Second Edition, New Age International, ISBN-13: 9788122412239.
2. J. E. Bowles, (2000), Foundation Analysis and Design, Fifth Edition, McGraw Hill Education India Pvt. Ltd., ISBN-13: 9781259061035.
3. P. C. Verghese, (2009), Design of Reinforced Concrete Foundations, First Edition, PHI Learning Pvt. Ltd., ISBN-13: 9788120336155.

| **Name of The Course** | **Design of Concrete Bridges** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6011** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. To understand the design and codal concepts of different types of bridges.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand IRC Code. |
| **CO2** | Use Pigeauds curves for designing deck slab for T-beam Bridge |
| **CO3** | Understand Courbon's method of load distribution to analyze and design girders for T-beam Bridge. |
| **CO4** | Design plate girders and steel truss bridges. |
| **CO5** | Design piers and abutments |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| **Unit I: Introduction and design of slab culvert** **8 Lecture Hours** |
|---|
| Site selection, various types of bridges, loads on bridges according to IRC codes, Design of RC bridges under concentrated loads using effective width method |
| **Unit II: Deck slab of T-Beam Bridges** **8 Lecture Hours** |
| Pigeauds curves, Calculation of bending moments, Design of deck slab for T-beam Bridge for different types of vehicles |
| **Unit III: Girders of T-Beam Bridge** **8 Lecture Hours** |
| Courbon's method of load distribution, Analysis and design of girders for T-beam Bridge for different types of vehicles, Concept of box culverts. |
| **Unit IV: Design of Plate Girders and Steel Trussed Bridges** **8 Lecture Hours** |
| Design principles, Design and detailing of plate girder bridges, Types of trusses, Design of steel trussed bridges. |
| **Unit V: Design of Substructures** **8 Lecture Hours** |
| Types of piers, Forces acting on piers, Design of piers, General features of abutments, Forces acting on abutments, Design of abutments. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Victor D. J. (2008), Essentials of Bridge Engineering, 6th Edition, Oxford University Press, ISBN: 9788120417175.
2. Ramachandra (2004), Design of Steel structures, 4th Edition, Standard Publishers Distributors, ISBN: 9780071544115.
3. Duggal S. K. (2008), Design of Steel Structures, 3rd Edition, Tata McGraw-Hill, ISBN: 9780070260689.

4. IRC Bridge Code.

| Name of The Course | Design of Industrial Structures | | | |
|---|---|---|---|---|
| Course Code | MSTR6012 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. This subject is taught to impart a broad knowledge in the area of industrial structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| CO1 | Know the requirements of various industries. |
| CO2 | Get an idea about the materials used and planning. |
| CO3 | Know the construction techniques. |
| CO4 | Learn about circulation, communication and transport. |
| CO5 | Understand the functional requirements. |
| CO6 | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Industrial requirements** **8 Lecture Hours** |
| General - Specific requirements for industries like textile, sugar, cement, chemical, etc - Site layout and external facilities. |
| **Unit II: Planning of building works** **8 Lecture Hours** |
| Planning of Building Work – Standards - Structural materials including plastics – Polymers - Fibre glass - Pressed card boards, etc - Multi-storey buildings - Steel skeletal structures - Reinforced concrete frames – Workshops - Ware houses - Single storey buildings - Sheds in steel and reinforced concrete - North-lights - Single span spherical and other special constructions - Cooling towers and chimneys - Bunkers and silos' prefabrication - Construction. |
| **Unit III: Construction techniques** **8 Lecture Hours** |
| Construction Techniques - Expansion joints - Machine foundations - Other foundations - Water proofing - Roofs and roofing - Roof drainage - Floors and flooring joists - Curtain walling - Outer wall facing - Sound and shock proof mountings - Use of modern hoisting and other construction equipments. |
| **Unit IV: Circulation** **8 Lecture Hours** |
| Circulation - Communication and Transport - Fixed points (central cores) – Staircases - Grid floor sections - Lifts refuse disposals - Utilization of waste materials – Cranes - Continuous conveyors - Mobile cranes – Transporters – Doors - Sliding gates. |
| **Unit V: Functional Requirements** **8 Lecture Hours** |
| Functional Requirements – Lighting: Natural lighting - Protection from the sun - sly lights - window cleaning installations -Services: Layout – wiring – fixtures - cable and pipe bridges - electrical installations - lighting substation - Effluent. Ventilation and fire protection: Ventilation - Air-conditioning - Fire escapes and chutes - Fire alarms - Extinguishers and hydrants. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. El Reedy, (2010), Construction Management and Design of Industrial Concrete and Steel Structures, Taylor & Francis Group, ISBN-13:9781439815991.
2. Nelson G. L., (1988), Light Agricultural and Industrial Structures: Analysis and Design Kluwer Academic Publisher, ISBN-13: 9780442267773.
3. Dr. Raja Rizwan Hussain, (2011), Pre-Cast Concrete for Multi-Storey Structures, Createspace Publisher, ISBN: 781467918220.

| Name of The Course | Earthquake Resistant Design |
|---|---|

| Course Code | MSTR6013 | | | |
|---|---|---|---|---|
| Prerequisite | MSTR5001 | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. To impart the knowledge about the earthquake and its occurrence.
2. To know about the mathematical modeling of structures subjected to earthquakes and their behaviour

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand about the basic of seismology. |
| **CO2** | Evaluate the behaviour of structures under dynamic loadings. |
| **CO3** | Know methodology for earthquake resistant design for shear walls. |
| **CO4** | Design the buildings using capacity design method. |
| **CO5** | Design seismic resistant multi storied building. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Basic of seismology &Theory of vibrations** **8 Lecture Hours** |
| Brief Introduction: Elements of Seismology – Definitions of magnitude – Intensity – Epicentre – General features of tectonics of seismic regions – Seismographs<br>Free vibrations of single degree freedom systems – Computations of dynamic response to time dependent forces –Solution of problems. |
| **Unit II: Dynamic analysis of building** **8 Lecture Hours** |
| Dynamic analysis of building – MDOF system – Eigen values and eigen vectors – Mode shape – Calculation of storey shear. |
| **Unit III: Earthquake resistant design of shear wall** **8 Lecture Hours** |
| Determination of design lateral forces – Design of shear wall – Detailing of reinforcements as per IS: 13920. |
| **Unit IV: Capacity design method** **8 Lecture Hours** |
| Capacity – Design Principles – Design criteria for strength – Stiffness and ductility – Earthquake Analysis – Concept of earthquake resistance design – Code provisions for design of RCC building – IS: 1893 and IS: 4326 – Energy absorption capacity - Behaviour and design of masonry buildings subjects to earthquake ground motion. |
| **Unit V: Multi storey building analysis** **8 Lecture Hours** |
| Seismic analysis and design of a multi storied building – Seismic retrofitting strategies for RC and masonry buildings. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Anil K. Chopra, (2011), Dynamics of Structures – Theory and Applications to Earthquake Engineering, Second Edition, Ingram International Inc., ISBN-13: 9780132858038.
2. Pankaj Agarwal and Manish Shrikhande, (2007), Earthquake Resistant Design of Structures, First Edition, Prentice-Hall India Pvt Ltd, ISBN-13: 9788120328921.
3. Gupta B. L., (2010), Principles of Earthquake Resistant Design of Structures & Tsunami, Standard Publishers & Distributors, ISBN-13: 9788180141485.

| Name of The Course | Design of Tall Buildings | | | |
|---|---|---|---|---|
| Course Code | MSTR6014 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. This course is intended to teach the concept of tall structures.

2. Various methods to analyze the tall structure will be explained in the classes.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the types of tall buildings. |
| **CO2** | Analyze the plane frame systems by different methods. |
| **CO3** | Design the shear wall systems |
| **CO4** | Know the details of in filled frame systems. |
| **CO5** | Perform the three dimensional analysis. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Classification of buildings** **8 Lecture Hours** |
| Introduction - Classification of buildings according to NBC – Types of loads – wind load – Seismic load – Quasi static approach |
| **Unit II: Plane frame systems** **8 Lecture Hours** |
| Plane Frame System - Calculation of wind load – Approximate method – Portal - Cantilever and factor methods – Kani's method – Substitute frame method for dead load and live loads |
| **Unit III: Shear wall system** **8 Lecture Hours** |
| Shear Wall System - Rosman's analysis – Design aspect – RC frame and shear wall interaction – Equivalent frame method |
| **Unit IV: In-filled frame system** **8 Lecture Hours** |
| In-filled Frame Systems - Importance – Methods of analysis – Equivalent truss and frame method – Force-displacement method – Effect of perforation in the in-filled frame. |
| **Unit V: Three dimensional analysis** **8 Lecture Hours** |
| Three Dimensional Analysis - Basic principles – Centre of rotation of a rigid floor – Force displacement method |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Bryan Stafford Smith and Alex Coull, (2011), Tall Building Structures: Analysis and Design, Wiley India, ISBN-13: 9788126529896.

2. SarwarAlamRaz, (2002), Structural Design in Steel, Second Edition, New Age International, ISBN-13: 9788122432282.

3. Ghali. A., Neville. A. M and Brown T. G, (2009), Structural Analysis - A unified classical and Matrix Approach, Sixth Edition, Span press, ISBN-13: 9780415774338

| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Energy Efficient Buildings** | | | |
| **Course Code** | **MSTR6015** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This course aims to highlight importance of Energy-Efficient Buildings within the context of Energy issues in the 21st century.
2. To familiarize students with the concept of Energy efficiency, Renewable sources of energy and their effective adaptation in green buildings
3. To give a full understanding of Building Form and Fabric, Infiltration, ventilation, Lighting, cooling and water conservation.
4. To highlight the importance of Environmental Management as well as Environmental impact Assessment methods in Energy efficient buildings.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand to make buildings energy efficient. |

| | |
|---|---|
| **CO2** | Have a fuller grasp on Renewable Energy mechanisms such as Passive Solar heating and collection, Photovoltaic's, and Ground source heat pumps, and their adaption to green building concepts. |
| **CO3** | Understand the concepts of Site and Climate, Building Form, Building Fabric, Infiltration and ventilation, Lighting, Heating, Cooling, Energy Management and water conservation. |
| **CO4** | Have the necessary skills to undertake an Environmental Impact Assessment study for Energy Efficient Buildings. They shall be equipped with the associated cutting-edge management strategies too. |
| **CO5** | Monitor energy consumption. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I:Green Buildings, Energy and Environment** **8 Lecture Hours** |
| Green Buildings within the Indian Context - Types of Energy - Energy Efficiency and Pollution - Better Buildings - Reducing energy consumption - Low energy design. |
| **Unit II: Renewable Energy, Site and Climate** **8 Lecture Hours** |
| Renewable Energy sources that can be used in Green Buildings - Solar energy - Passive Solar Heating - Passive Solar collection - Wind and other renewable - A passive solar strategy - Photovoltaics - Climate and Energy - Macro and Microclimate - Indian Examples. |
| **Unit III: Building Form and Fabric** **8 Lecture Hours** |
| Building Form - Surface area and Fabric Heat Loss - utilizing natural energy - Internal Planning - Grouping of buildings - Building Fabrics - Windows and doors - Floors - Walls - Masonry - Ecological walling systems - Thermal Properties of Construction Material. |
| **Unit IV: Infiltration, Ventilation, Lighting, Cooling and Water Conservation** **8 Lecture Hours** |
| Infiltration and ventilation - Natural ventilation in commercial buildings - passive cooling - modeling air flow and ventilation - Concepts of daylight factors and day lighting - daylight assessment - artificial lighting - New light sources - Cooling buildings - passive cooling - mechanical cooling - Water conservation- taps, toilets and urinals, novel systems - collection and utilization of rain water. |
| **Unit V: Energy Awareness** **8 Lecture Hours** |
| Energy awareness - monitoring energy consumption - Building Environmental Assessment - environmental criteria - assessment methods - assessment tools (e.g. LEED) – Ecohomes - Sustainable architecture and urban design - principles of environmental architecture - Benefits of green buildings - Energy Conservation Building code – NBC. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. William T. Meyer, (2007), Energy Economics and Building Design, McGraw - Hill, ISBN: 9780070417519.
2. Sim Van Der Ryn and Stuart Cowan, "Ecological Design", Annotated Edition, Island Press ISBN-13: 9781597261418.
3.Richard D. Rush, (1991), The Building System Integration Handbook., Butterworth – Heinemann Ltd, ISBN-13: 9780750691987.

| **Name of The Course** | **Environmental Engineering Structures** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6016** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject is taught to impart the knowledge in the area of analysis and design of pipes and sewage structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the concepts of pipe network and design. |
| **CO2** | Design the water tanks and concrete roofing systems. |
| **CO3** | Understand the economic analysis of tanks. |
| **CO4** | Design the special purpose structures. |
| **CO5** | Understand the concepts of filter walls and clarifiers. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Pipe design** **8 Lecture Hours** |
| Design of Pipes - Structural design of concrete - Pre-stressed concrete steel and cast iron piping mains - Sewerage tanks design - Anchorage for pipe – Massive outfalls – Structural design and laying – Hydrodynamic considerations. |
| **Unit II: Water tank design** **8 Lecture Hours** |
| Analysis and design of water tanks - Design of concrete roofing systems using cylindrical, spherical and conical shapes using membrane theory and design of various types of folded plates for roofing using concrete - IS Codes for the design of water retaining structures. |
| **Unit III: Economic analysis** **8 Lecture Hours** |
| Design of circular, rectangular, spherical and Intze type of tanks using concrete - Design of pre-stressed concrete cylindrical tanks – Economic analysis. |
| **Unit IV: Swimming pools** **8 Lecture Hours** |
| Design of Special Purpose Structures - Underground reservoirs and swimming pools - Intake towers - Structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks etc. – Effect of earth pressure and uplift considerations – Selection of materials of construction |
| **Unit V: Mixing tank** **8 Lecture Hours** |
| Design of filter walls and clarifiers - Mixing tanks. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. P. Dayaratnam, (2011), Design of Reinforced Concrete Structures, Fourth Edition, Oxford & IBH – Pubs Company, ISBN-13: 9788120414198.
2. M. L. Gambhir, (2009), Design of Reinforced Concrete Structures, First Edition, Phi Learning Pvt. Ltd., ISBN-13: 9788120331938.
3.Krishna Raju, (2004), Pre-stressed Concrete (Problems and Solutions), Second Edition, CBS Publishers & Distributors, ISBN-13: 9788123902174.

| **Name of The Course** | **Experimental Stress Analysis** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6017** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject is taught to impart knowledge about the instruments and its applications.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the working principle of strain gauges. |
| **CO2** | Perform the model analysis using different theorems. |
| **CO3** | Know the concepts of photo elasticity and its applications. |
| **CO4** | Understand the processes of scattered light photo elasticity. |
| **CO5** | Use the various Non-destructive testing methods. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Strain gauges** **8 Lecture Hours** |
| Strain Gauges - Mechanical and optical strain gauges – Description and operation – Electrical resistance- Inductance and capacitance gauges – Detailed treatment on resistant gauges – Measurement of static and dynamic strains – Strain rosettes – Effect of transverse strains – Use of strain recorders and load cells. |
| **Unit II: Model Analysis** **8 Lecture Hours** |
| Model Analysis - Structural similitude – Use of models – Structural and dimensional analysis – Buckingham Pi Theorem – Muller Breslau's principle for indirect model analysis – Use of Begg's and Eney's deformeters – Moment indicators – Design of models for direct and indirect analysis. |
| **Unit III:Two dimensional photo elasticity** **8 Lecture Hours** |
| Two dimensional photo elasticity - Stress optic law – Introduction to polariscope – Plane and circular polariscope – Compensators and model materials – Material and model fringe value – Calibration of photo elastic materials – Isochromatic and isoclinic fringes – Time edge effects. |
| **Unit IV: Three dimensional photo elasticity** **8 Lecture Hours** |
| Three dimensional photo elasticity - Introduction – Stress freezing techniques – Stress separation techniques – Scattered light photo elasticity – Reflection polariscope |
| **Unit V: Non-destructive testing** **8 Lecture Hours** |
| Miscellaneous Methods - Brittle coating method – Birefringence techniques – Moire fringe method – Non-destructive testing – Ultrasonic pulse velocity technique – Rebound hammer method – X-ray method – Gamma-ray method. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Jindal, (2012), Experimental Stress Analysis, Pearson India, ISBN-13: 9788131759103

2. J. Srinivas, (2012), Stress Analysis and Experimental Techniques: An Introduction, Alpha Science International Ltd, ISBN-13: 9781842657232.

3. Sadhu Singh, (2009), Experimental Stress Analysis, Khanna Publishers, ISBN-13: 9788174091826.

| Name of The Course | Machine Foundations | | | |
|---|---|---|---|---|
| Course Code | MSTR6018 | | | |
| Prerequisite | - | | | |
| Co-requisite | - | | | |
| Anti-requisite | - | | | |
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. This subject is taught to impart the knowledge of dynamic behaviour of soils, effects of dynamic loads and the various design methods.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the basic principles of soil dynamics. |
| **CO2** | Understand the elastic properties of soil. |
| **CO3** | Learn the multi degree freedom system. |
| **CO4** | Know the mathematical models for dynamic analysis. |
| **CO5** | Understand the concepts of stiffness, damping, inertia, guide lines for design. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Introduction** |

| 8 Lecture Hours |
|---|
| Introduction: Elements of soil dynamics – Basic definitions – Importance of dynamics analysis – general requirements of machine foundations – types of machine foundation |
| **Unit II: Properties of soil** **8 Lecture Hours** |
| Elastic properties of soils – Elastic deformation of soils and elastic constants - co-efficient of elastic uniform compression of soils - co-efficient of elastic non-uniform compression of soil, co-efficient of elastic uniform shear of soil, effect of vibration on the dissipatice properties of soil, effect of vibration on the porosity and hydraulic properties of soils, elements of the theory of residual settlements of decrease the residual dynamic settlement of foundations. |
| **Unit III: Design parameters** **8 Lecture Hours** |
| Theory of massive machine foundation – theory of single and multi degree freedom, system – Evaluation of Design parameters – vertical vibrations of foundations, rocking, vibration of foundations, vibration of pure shear, vibration of foundations accompanied by simultaneous rotations. |
| **Unit IV: Block foundation** **8 Lecture Hours** |
| Analysis and Design of foundation - models of vibration of block foundation – method of analysis for block foundation, design procedure from block foundations – relevant code for design of foundation, foundations for impact load and cyclic load – design data – Barker's Empirical procedures, analog models for dynamic analysis of single pile. Dynamic bearing capacity, earth pressure, dynamic soil structure interaction |
| **Unit V: Vibration isolation** **8 Lecture Hours** |
| Vibration isolation – active and passive types of isolation – methods of isolation in machine foundation – properties of isolating materials – guide lines for design and construction details of machine foundation |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. K. G. Bhatia, (2007), Foundations for Industrial Machines: Handbook for Practicing Engineers, D-Cad Publishers, ISBN-13: 9788190603201.
2. Srinivasulu P. and Vaidyanathan C. V., (2004), Hand Book of Machine Foundations, First Edition, Tata Education Pvt. Ltd., ISBN-13: 9780070966116.
3. Shambhu P. Dasgupta&Indrajit Chowdhury, (2009), Dynamics of Structures and Foundations: A Unified Approach: Fundamentals (Volume 1), First Edition, Taylor & Francis Publishers, ISBN-13: 9780415471459.

| **Name of The Course** | **Maintenance & Rehabilitation of Structures** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6019** | | | |
| **Prerequisite** | **MSTR5003** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject imparts a broad knowledge in the area of repair and rehabilitation of structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the properties of fresh and hardened concrete. |
| **CO2** | Know the strategies of maintenance and repairing. |
| **CO3** | Get an idea of repairing techniques. |
| **CO4** | Understand the properties of repairing materials. |
| **CO5** | Know about weathering wear, fire leakage and marine exposure. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| **Unit I: Properties of concrete** **8 Lecture Hours** |
|---|

| |
|---|
| Serviceability and Durability of Structures - Quality Assurance for concrete construction - Fresh concrete properties – Strength – Permeability - Cracking - Effects due to climate – Temperature – chemicals - Wear and erosion - Design and construction errors - Corrosion mechanism - Effects of cover thickness and cracking - Methods of corrosion protection – Inhibitors - Resistant steels – Coatings - Cathodic protection |
| **Unit II: Repairing materials** **8 Lecture Hours** |
| Diagnosis and Assessment of Distress - Visual inspection – Non destructive tests –Ultrasonic pulse velocity method – Rebound hammer technique – ASTM classifications – Pullout tests – Core test |
| **Unit III: Repairing techniques** **8 Lecture Hours** |
| Materials for Repairing - Special concretes and mortar - Concrete chemicals - Special elements for accelerated strength gain - Expansive cement - Polymer concrete – Ferro cement, Fibre reinforced concrete - Fibre reinforced plastics. |
| **Unit IV: Repairs to structures** **8 Lecture Hours** |
| Techniques for Repair - Rust eliminators and polymers coatings for rebars during repair - Foamed concrete - Mortar and dry pack - Vacuum concrete - GModulee and shotcrete - Epoxy injection - Mortar repair for cracks - Shoring and underpinning. |
| **Unit V: Example of Repairs to Structures** **8 Lecture Hours** |
| Example of Repairs to Structures - Repairs to overcome low member strength – Deflection – Cracking - Chemical disruption - Weathering wear - Fire leakage - Marine exposure |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Shetty M. S., (2008), Concrete Technology, Seventh Edition, S. Chand & Company Ltd.ISBN-13: 9788121900034.

2. Ravindra K. Dhir, M. Roderick Jones & Li Zheng, (2005), Repair and Renovation of Concrete Structures, American Society of Civil Engineers, ISBN-13: 9780727734051.

3. A. R. Santha Kumar, (2006), Concrete Technology, First Edition, Oxford University Press, ISBN-13: 9780195671537.

| **Name of The Course** | **Theory and Design of Plates & Shells** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6020** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject is taught to impart knowledge about the behavior of plates and shells.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the concept of thin plates |
| **CO2** | Analyze laterally loaded circular plates. |
| **CO3** | Analyze laterally loaded thin plates. |
| **CO4** | Understand the concept of shells. |
| **CO5** | Analyze and design of doubly curved shells |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Thin plates** **8 Lecture Hours** |
| Introduction:- Assumptions in the theory of thin plates – Pure bending of Plates –Relations between bending moments and curvature - Particular cases of pure bending of rectangular plates, Cylindrical bending - immovable simply supported edges – Synclastic bending and Anticlastic bending – Limitations - Boundary conditions. |
| **Unit II: Circular plates** **8 Lecture Hours** |

| |
|---|
| Laterally Loaded Circular Plates:- Differential equation of equilibrium – Uniformly loaded circular plates with simply supported and fixed boundary conditions – Annular plate with uniform moment and shear force along the boundaries. |
| **Unit III: Plate bending** **8 Lecture Hours** |
| Laterally loaded thin plates – Differential equation of plates - Navier's solution and Levy's method – Rectangular plates with various edge conditions |
| **Unit IV: Theory of shells** **8 Lecture Hours** |
| Types of shells – Structural action – Membrane theory – Limitations – Beam method of analysis. |
| **Unit V: Curved shell** **8 Lecture Hours** |
| Analysis and design of doubly curved shells – Elliptic paraboloid - Conoid and hyperbolic paraboloid roofs. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. G. S. Ramaswamy, (1996), Design and Construction of Concrete Shell Roofs, First Edition, CBS Publishers and distributors. ISBN-13: 9780812390995.

2. Timoshenko and Krieger, (2010), Theory of Plates and Shells, Second Edition, Tata McGraw Hill Education Pvt. Ltd., ISBN-13: 9780070701250.

3. K. Bhaskar, (2013), Plates: Theories and Applications, First Edition, Ane Books Pvt. Ltd., ISBN-13: 9789382127024.

| **Name of The Course** | **Offshore Structures** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6021** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject is taught to impart knowledge about analysis and design of offshore structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the effect of wind on structures. |
| **CO2** | Know about wave generation and propagation. |
| **CO3** | Calculate wave forces. |
| **CO4** | Design plat forms, derrick, jacket towers. |
| **CO5** | Learn the principles of jacketing towers. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Rigid and flexible structures** **8 Lecture Hours** |
| Wind on structures - Rigid structures - Flexible structures - Static and Dynamic effects. |
| **Unit II: Wave generation** **8 Lecture Hours** |
| Wave generation and Propagation - Small and finite amplitude wave theories - Wave energy and pressure distribution. |
| **Unit III: Wave forces** **8 Lecture Hours** |
| Wave forces on structures - Environmental loading - Use of Morrison equation. |
| **Unit IV: Types of structures** **8 Lecture Hours** |
| Loads - Design of platforms – Derricks – Helipads – Design. |
| **Unit V: Design of platform, helipad etc** **8 Lecture Hours** |
| Principles and examples of Jacket towers - Mooring cables. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Gerwick, (1999), Construction of Marine and Offshore Structure, Second Edition, CRC Press, ISBN-13: 9780849374852.

2. Lymon C. Reese, Bruce J. Muga& James F. Wilson, Offshore Structures, Second Edition, John Wiley & Sons, ISBN-13: 978047121264675.

3.Templetion J. S., (2007), Offshore Technology in Civil Engineering, Hall of Fame, Papers from the Early Years, Volume-2, American Society of Civil Engineers, ISBN-13: 9780784409251.

| **Name of The Course** | **Prefabricated Structures** | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6022** | | | |
| **Prerequisite** | **-** | | | |
| **Co-requisite** | **-** | | | |
| **Anti-requisite** | **-** | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject is taught to impart the knowledge in the area of prefabricated structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the types of prefabrication systems. |
| **CO2** | Understand about handling and erection stresses. |
| **CO3** | Learn about construction and expansion joints |
| **CO4** | Understand the process of erection of R.C. structures. |
| **CO5** | Design pre fabricated modules. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| **Internal Assessment (IA)** | **Mid Term Exam (MTE)** | **End Term Exam (ETE)** | **Total Marks** |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| **Unit I: Introduction** **8 Lecture Hours** |
|---|
| Types of foundation - Modular co-ordination – Components - Prefabrication systems and structural schemes - Design considerations - Economy of prefabrication - Prefabrication of load-carrying members - DisModuleing of structures - Structural behaviour of pre cast structures. |
| **Unit II: Handling and erection stresses** **8 Lecture Hours** |
| Handling and erection stresses - Application of pre stressing of roof members - Floor systems - Two way load bearing slabs - Wall panels |
| **Unit III: Dimensioning and detailing of joints** **8 Lecture Hours** |
| Dimensioning and detailing of joints for different structural connections - Construction and expansion joints. |
| **Unit IV: Erection of structures** **8 Lecture Hours** |
| Production - Transportation and Erection - Organizing of production - Storing and erection equipment - Shuttering and mould design - Dimensional tolerances, Erection of R.C. structures, Total prefabricated buildings |
| **Unit V: Design of pre fabricated Modules** **8 Lecture Hours** |
| Prefabricated Modules for Industrial structures - Multi-storied buildings and Water tanks - Application of pre stressed concrete in prefabrication |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Hass, A. M., (1995) Precast concrete Design and Applications, Applied Science Publishers, England.

2. Promyslov, V. (1998), Design and Erection of Reinforced concrete structures, MIR Publishers, Moscow.ISBN: 0719024323.

3. Levit, M., (2000), Precast concrete materials, Manufacture properties and usage, Applied Science Publishers, London. ISBN 0-203-79881-3

| **Name of The Course** | **Pre-stressed Concrete Structures** |
|---|---|
| **Course Code** | **MSTR6023** |
| **Prerequisite** | **-** |
| **Co-requisite** | **-** |

| Anti-requisite | - | | | |
|---|---|---|---|---|
| | L | T | P | C |
| | 3 | 0 | 0 | 3 |

**Course Objectives**

1. This subject is taught to give the concepts of pre-stress.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Know the concepts, methods and materials of pre-stressing systems. |
| **CO2** | Design the pre-stressed concrete members. |
| **CO3** | Calculate the deflections in pre-stressed concrete members. |
| **CO4** | Design anchorage zones and composite pre-stressed concrete members. |
| **CO5** | Know the concepts of pre-stressed concrete beams. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Materials and losses in pre stress** **8 Lecture Hours** |
| Difference between reinforced and pre-stressed concrete – Principles of pre-stressing – Methods and systems of pre-stressing – Principles of pre-stressing – Classification of pre-stressed concrete structures – Materials – High strength concrete and High strength steel – Stress-strain diagram - Losses in pre-stress. |
| **Unit II: Design of pre-stressed concrete beam** **8 Lecture Hours** |
| Design of prismatic pre-stressed concrete members for bending at service load. |
| **Unit III: Deflections** **8 Lecture Hours** |
| Simple cable profiles – Calculation of deflections – Design of beams for shear and torsion at working and ultimate loads. |
| **Unit IV: Anchorage design** **8 Lecture Hours** |
| Design of Anchorage zone by Guyon's method – Concept of Magnel's method – IS:1343 recommendations |
| **Unit V: Composite prestressed concrete beams** **8 Lecture Hours** |
| Pre-stressed concrete beams – Design procedure – Calculation of stresses at important stages both for propped and unpropped constructions – Shrinkage stresses - Statically indeterminate structures – Concept of concordant cable and profile – Sketching of pressure lines for continuous beams. |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Krishna Raju.N, (2004), Pre stressed Concrete, Third Edition, Tata McGraw Hill Co

2. Rajagopal.N, (2005), Prestressed Concrete, Second Edition, Narosa Publishing House.ISBN 13, : 9788173195433

3.Dayarathnam P, (2004), Prestressed Concrete Structures, S.Chand Publishers.

4.Sinha.N.C and Roy.S.K, (2000), Fundamentals of Pre-stressed Concrete, S.Chand & Company

| Name of The Course | Soil Structure Interaction | | | |
|---|---|---|---|---|
| **Course Code** | **MSTR6024** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This subject is taught to impart knowledge on soil structure interaction analysis, its influences in the design parameters.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the concept of different soil models. |

| | |
|---|---|
| **CO2** | Calculate modulus of subgrade for different types of soil. |
| **CO3** | Carry out soil structure interaction for shallow foundation. |
| **CO4** | Do the elastic analysis of piles and pile groups. |
| **CO5** | Know non-linear soil properties. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Mathematical model, Winkler model, Two parameter model** **8 Lecture Hours** |
| Soil models: single parameter model (Winkler), two parameter models – Filonenko - Borodich model, Pasternak model, Heteni model, visco elastic model, elastic continuum model, contact pressure distribution below the flexible and rigid footing and. raft parameter affecting conduct pressure. |
| **Unit II: Modulus of subgrade, reaction** **8 Lecture Hours** |
| Contact pressure and subgrade modulus and beams on elastic foundation method - analysis of contact pressure distribution – modulus of subgrade reaction – classical solution for beam of infinite length subjected to concentrated load and moment, beams of finite length (formulation of basic equation for slabs resting on elastic foundation), Application of design of combined footing. |
| **Unit III: Beams and slabs** **8 Lecture Hours** |
| Plates in elastic medium – soil structure interaction for shallow foundation – interface behaviour - Thin and thick plates – analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions, Baker's method for rafts. |
| **Unit IV: Analysis of piles** **8 Lecture Hours** |
| Soil pile interaction : Introduction – elastic analysis of single pile, theoretical solutions for settlement and load distribution analysis of pile group interaction analysis – Load distribution with groups with rigid cap – elastic continuum and elasto-plastic analysis of piles and pile groups (Ultimate lateral resistance of piles by various approaches). |
| **Unit V: Pile displacement** **8 Lecture Hours** |
| Laterally loaded pile and piled raft: Non-linear load – deflection response P-Y reactions, non-linear soil properties lift capacity of piles and anchors, Piles raft system – soil structure interaction in framed structures. FEM modules use of approximately software packages |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Selvadurai A.P.S., Elastic Analysis-Soil foundation interaction.ISBN 13: 9780444416636
2. Hetenyi, M; Beams on elastic foundation. ISBN: 0472084453
3. Baker, A.L.L. Raft foundation, The Soil line method of design ISBN 10: 8122410782
4. Nainan P. Kurian, Design of foundation systems (Narosa) ISBN: 978-81-7319-939-4
5. Structure –Soil interaction – State of art report, Institute of Structural Engineers, 1978
6. ACl-336 suggested Analysis and design practice, for combined footings and mats.
American Concrete Institute, Delhi - 1988.
7. Poulous, H.G. and Davis, E.H, Pile foundation analysis and design, John Wiley, 1980, ISBN 10: 0471020842

| | | | | | |
|---|---|---|---|---|---|
| **Name of The Course** | **Stability of Structures** | | | | |
| **Course Code** | **MSTR6025** | | | | |
| **Prerequisite** | - | | | | |
| **Co-requisite** | - | | | | |
| **Anti-requisite** | - | | | | |
| | **L** | **T** | **P** | **C** | |
| | **3** | **0** | **0** | **3** | |

**Course Objectives**

1. This subject is taught to impart the knowledge in the area of stability of structures.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the behaviour of columns. |
| **CO2** | Learn the theory of the beam columns. |
| **CO3** | Analyse the frame stability. |
| **CO4** | Analyse the frame stability. |
| **CO5** | Understand the concept of buckling of shells. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Column analysis** **8 Lecture Hours** |
| Introduction - Static equilibrium – Governing equation for columns – Analysis for various boundary conditions - Analysis of Eccentrically loaded column. |
| **Unit II: Beam column analysis** **8 Lecture Hours** |
| Beam Columns – Theory of Beam column – Stability analysis of beam column with different types of loads – Failure of beam columns. |
| **Unit III: Frames stability** **8 Lecture Hours** |
| Analysis and stability of frames. |
| **Unit IV: Plates** **8 Lecture Hours** |
| Plates subjected to in plane forces - Differential equation – Analysis – Approximate techniques - Analysis for various boundary conditions – Wood and Armer equation for analysis and design. |
| **Unit V: Shells** **8 Lecture Hours** |
| Buckling of shells – Differential equation – Analysis – Application |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Aswini Kumar, (2002), Stability theory of structures, Tata McGraw Hill Publishing Co.Limited, New Delhi.
2. Timoshenko & Gere (2000), Theory of Elastic Stability, McGraw Hill. ISBN-13: 978-0-486-47207-2
3.N.G.R. Iyengar (1996), Structural Stability of Columns and Plates, Affiliated East West Press, ISBN 81-85814-24-4. 3.

| | | | | |
|---|---|---|---|---|
| **Name of The Course** | **Structural Optimization** | | | |
| **Course Code** | **MSTR6026** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. This course is intended to teach the importance of Optimization problems in the Structural Engineering.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Understand the concepts of Optimization problems in the Structural Engineering. |
| **CO2** | Know the different methods for the Optimization problems. |
| **CO3** | Understand the concepts of Linear and Non-Linear Programming techniques. |
| **CO4** | Understand the concepts of Stochastic Optimization Methods. |
| **CO5** | Understand the concepts of Genetic Algorithm based Optimization Methods. |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| 20 | 30 | 50 | 100 |

**Course Content:**

| |
|---|
| **Unit I: Formulation of Structural Optimization problems** **8 Lecture Hours** |

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|---|
| Formulation of Structural Optimization problems: Design variables - Objective function - constraints. Fully stressed design. |
| **Unit II: Linear Programming techniques** **8 Lecture Hours** |
| Review of Linear Algebra: Vector spaces, basis and dimension, canonical forms. |
| **Unit III: Non-Linear Programming techniques** **8 Lecture Hours** |
| Linear Programming: Revised Simplex method, Application to structural Optimization. |
| **Unit IV: Stochastic Optimization Methods** **8 Lecture Hours** |
| Nonlinear Programming: Deterministic Methods_ Unconstrained and constrained Optimization - Kuhn-Tucker conditions, Direct search and gradient methods - One dimensional search methods - DFP and BFGS algorithms, constrained Optimization - Direct and Indirect methods - SLP, SQP and SUMT, Application of NLP methods to optimal structural design problems. Optimality criteria based methods, Reanalysis techniques - Approximation concepts - Design sensitivity Optimization of sections, steel and concrete structures - framed structures, bridge structures. |
| **Unit V: Genetic Algorithm based Optimization Methods** **8 Lecture Hours** |
| Genetic Algorithm based Optimization Methods |
| **Unit VI: Discussion on Latest Research Paper** **2 Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. S.S.Rao, (1996), Engineering Optimization: Theory and Practice, Third Edition, John Wiley &Sons,Inc.ISBN 0-471-55034-5

2. Smith, D. R., "Variational Methods in Optimization," Dover Publications, 1998. ISBN, 0486404552,

3. Haftka, R. T. and Gurdal, Z., "Elements of Structural Optimization," Kluwer Academic Publishers, 1992. ISBN, 0792315049

4. Bendsoe, M. P. and Sigmund, O., "Topology Optimization: Theory, Methods, and Applications," Springer, 2003. ISBN-10: 3540429921

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|---|---|---|---|---|
| **Name of The Course** | **Composite Structures** | | | |
| **Course Code** | **MSTR6027** | | | |
| **Prerequisite** | - | | | |
| **Co-requisite** | - | | | |
| **Anti-requisite** | - | | | |
| | **L** | **T** | **P** | **C** |
| | **3** | **0** | **0** | **3** |

**Course Objectives**

1. To know the types of composites
2. To understand the need for stress strain relation
3. To understand the fabrication methods
4. To understand the laminated plates
5. To study and understand the different methods & analysis of composite materials.

**Course Outcomes**

On completion of this course, the students will be able to

| | |
|---|---|
| **CO1** | Analyze composite structures |
| **CO2** | Do microscopic and macroscopic analysis |
| **CO3** | Analyze sandwich and laminated plates |
| **CO4** | Understand the failure criteria for composites. |
| **CO5** | Know the fabrication techniques |
| **CO6** | Discuss on Latest Research Paper. |

**Continuous Assessment Pattern**

| Internal Assessment (IA) | Mid Term Exam (MTE) | End Term Exam (ETE) | Total Marks |
|---|---|---|---|
| **20** | **30** | **50** | **100** |

**Course Content:**

| |
|---|
| **Unit I: Stress Strain Relationship** **8 Lecture Hours** |
| Introduction - advantages and application of composite materials, reinforcements and matrices - Generalised Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials. |
| **Unit II: Finite Element Analysis of Plates** **8 Lecture Hours** |
| Introduction - concept of mesh - Displacement function - Stress-Strain Matrix – Stiffness matrix of plate element – Solution of problem |
| **Unit III: Methods of Analysis** |

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|---|
| **8 Lecture Hours** |
| Micro mechanics - Mechanics of materials approach, elasticity approach to determine material properties - Macro Mechanics - Stress-strain relations with respect to natural axis, arbitrary axis - Determination of material properties - Experimental characterization of lamina. |
| **Unit IV: Laminated Plates** **8 Lecture Hours** |
| Governing differential equation for a general laminate, angle ply and cross ply laminates - Failure criteria for composites. |
| **Unit V: Sandwich Constructions, Fabrication Process** **8 Lecture Hours** |
| Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels - Various Open and closed mould processes - Manufacture of fibers - Types of resins and properties and applications – Netting analysis. |
| **Unit VI: Discussion on Latest Research Paper** **2** **Lecture Hours** |
| This unit is based on research papers / Innovations / start-up ideas / white papers / applications. Minimum one latest research paper will be discussed in the class. |

**Suggested Reading**

1. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Noastrand Reinhold Company, New York 1991.ISBN0-324-06680-5

2. Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1915.ISBN 81-297-0277-0

3. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York. ISBN 0-324-06680-5

4. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York.ISBN 0-324-06680-5

5. J. N. Reddy, "Mechanics of Laminated Composite Plates and Shells - Theory and Analysis", CRC Press USA), ISBN 9780849315923.