# PG-Curriculum

**(Structure and Course Contents)**

# Structural Engineering

**With effect from July 2018**

EXPLORE INNOVATE EXCEL

## Civil Engineering Department

## Punjab Engineering College

**(Deemed to be University)**

## Chandigarh

## PG Curriculum Structure

| Sr. No. | Course Stream | Course Name | Credits | When it runs in a semester | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 |
| **Semester I** | | | | | | | | | |
| 1. | Soft Computing | Internet of Things | 1.5 | ■ | ■ | ■ | | | |
| | | Machine Learning | 1.5 | | | | ■ | ■ | ■ |
| 2. | Soft Skills and Management | Communication Skills (CS) | 1.5 | ■ | ■ | ■ | | | |
| | | Management and Entrepreneurship(M)/IPR | 1 | | | | ■ | ■ | |
| | | Professional Ethics (PE) | 0.5 | | | | | | ■ |
| 3. | Program Core-I | Advanced Reinforced Concrete Structures | 3 | ■ | ■ | ■ | ■ | ■ | ■ |
| 4. | Program Core-II | Structural Dynamics | 3 | ■ | ■ | ■ | ■ | ■ | ■ |
| 5. | Program Elective-I: E1 | • High Rise Buildings<br>• Theory of Plated Structures<br>• Advanced Concrete Technology<br>• Advanced Soil Engineering | 1.5 | ■ | ■ | ■ | | | |
| | Program Elective-II: E2 | • Pre-stressed Concrete Structures<br>• Wind Engineering<br>• Construction Engineering<br>• Advanced Solid Mechanics | 1.5 | | | | ■ | ■ | ■ |
| 6. | Engineering Mathematics (EM) | Engineering Mathematics- I (Fourier Transform) | 1 | ■ | ■ | | | | |
| | | Engineering Mathematics- II (Numerical Methods) | 1 | | | ■ | ■ | | |
| | | Engineering Mathematics- III (Optimization techniques) | 1 | | | | | ■ | ■ |
| | | **Total Credits** | **18** | | | | | | |

| Sr. No. | Course Stream | Course Name | Credits | When it runs in a semester | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 |
| **Semester II** | | | | | | | | | |
| 1. | Design of experiments and research methodology | Design of Experiments and Research Methodology | 3 | | | | | | |
| 2. | Program Core III | Advanced Steel Structures | 3 | | | | | | |
| 3. | Program Core-IV | Advanced Structural Analysis | 3 | | | | | | |
| 4. | Program Elective-III: E3 | • Advanced Foundation Engineering<br>• Seismic Design of Structures<br>• Computer Aided Design | 1.5 | | | | | | |
| | Program Elective-IV: E4 | • Bridge Engineering<br>• Rehabilitation of Structures<br>• Liquid Retaining Structures | 1.5 | | | | | | |
| 5. | Open Elective | Seismic Design of Structures | 1.5 | | | | | | |
| | | Rehabilitation of Structures | 1.5 | | | | | | |
| 6. | Mini project/ Pre-dissertation | | 3 | | | | | | |
| | | **Total Credits** | **18** | | | | | | |

**Summer Term ***

| Sr. no. | Course Code | Course Name | Credits |
|---|---|---|---|
| 1 | | Industrial Visit (3 days to 1 week of visit, Submission and presentation of visit report) | Satisfactory/ Non-satisfactory |

***After Examination of second semester, in the first week of summer vacation industry visit can be undertaken.**

| Course No. | Course Name | Credits | When it runs in a semester | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 |
| **Semester-III** | | | | | | | | |
| 1. | Dissertation/Industry Project | 14 | | | | | | |

| Course No. | Course Name | Credits | When it runs in a semester | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 |
| **Semester-IV** | | | | | | | | |
| 1. | Dissertation/Industry Project | 18 | | | | | | |

**Total credits – 68**

- ***20% courses/ semester can be offered in blended mode MOOC's/Industry.***
- ***MOOC's/Industry offered course is having fractional credits. Industry offering course content will be designed by industry will be as per expert availability. Industry person will deliver and evaluate this subject. As per the duration of MOOC's/industry offered course, credits of this course can be decided (fractional credits).***

# Semester-I

# Soft Computing

| | | |
|---|---|---|
| **Course Name** | **:** | **Internet of Things** |
| **Course Code** | **:** | **SCM 5011** |
| **Credits** | **:** | **1.5** |
| **L T P** | **:** | **2-0-2** |
| **Segments** | **:** | **1-3** |

**Total No. Lectures:-14**
**Total No. of Lab hours – 14**

**Course Objectives:**

- The student should be able to understand IoT architecture and market perspective. Also, student should be able to understand the basic principles and operation of different types of sensors commonly used on mobile platforms.

Course Contents:

| Sr.No | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Introduction to IOT**<br>What is IoT, how does it work? Difference between Embedded device and IoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market , Privacy issues in IOT | **2** |
| **2.** | **Setting Up Raspberry Pi/Arduino to Create Solutions**<br>Explore Raspberry Pi, Setting up Raspberry Pi, Showing working of Raspberry Pi using SSH Client and Team Viewer, Understand Sensing actions, Understand Actuators and MEMS. | **3** |
| **3.** | **Communication Protocols used in IoT**<br>Types of wireless communication, Major wireless Short-range communication devices, properties, comparison of these devices (Bluetooth, WIFI, ZigBee, 6LoWPAN), Major wireless Long-range communication devices, properties, comparison of these devices (Cellular IoT, LPWAN) | **3** |
| **4.** | **IoTApplications**<br>IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Smart Grids , Brownfield IoT, Smart Objects, Smart Applications | **3** |
| **5.** | **Sensors**<br>Applications of various sensors: Google Maps, Waze, WhatsApp, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras<br>Global positioning sensors: GPS, GLONASS, IRNSS, Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, Proximity Sensor, Gyroscope, Calibration, - noise Modeling and characterization, and - noise filtering and sensor data processing, Privacy & Security, Selection of Sensors for Practical Applications | **3** |

**Lab Work:**

| S.No. | Lab contents | No. of Hours |
|---|---|---|
| **1.** | Setting up Raspberry Pi and Arduino | **2** |
| **2.** | Build small scale wireless communicating IOT device | **4** |
| **3.** | Integrate positioning sensors to IOT device | **4** |
| **4.** | Integrate motion and orientation sensors to IOT device | **4** |

**Course Outcomes:**

| At the end of the course, students will have: | |
|---|---|
| **1.** | Understand the concept of IOT |
| **2.** | Study IOT architecture and applications in various fields |
| **3.** | Study the security and privacy issues in IOT. |
| **4.** | Understand various applications of sensor in Industrial, healthcare, commercial, and building automation. |

**Bibliography:**


| S. No. | Name of Book/ Authors/ Publisher | Year of Publication/Reprint |
|---|---|---|
| **1.** | Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", VPT, 1st Edition | **2014** |
| **2.** | Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, 1st Edition | **2013** |
| **3.** | CunoPfister, "Getting Started with the Internet of Things", O-Reilly Media | **2011** |
| **4.** | Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing | **2015** |

| | | |
|---|---|---|
| **Course Name** | **:** | **Machine Learning** |
| **Course Code** | **:** | **SCM 5012** |
| **Credits** | **:** | **1.5** |
| **L T P** | **:** | **2-0-2** |
| **Segments** | **:** | **4-6** |

**Total No. Lectures:-14**
**Total No. of Lab hours – 14**

**Course Objectives:**

1. The students should be able to design and implement machine learning solutions to classification, regression and clustering problems; and be able to evaluate and interpret the results of the algorithms

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Python**<br>Introduction, Conditional Statements, Looping, Control Statements, String Manipulation, Lists, , Tuple, Dictionaries, Functions, Modules, Input-Output, Exception Handling | **4** |
| **2.** | **Supervised Learning**<br>Linear Regression, Support Vector Machines, Decision Tree Learning | **3** |
| **3.** | **Unsupervised Learning**<br>K-means, hierarchical clustering, principal component analysis, Neural Networks | **4** |
| **4.** | **Reinforcement and Control Learning**<br>Introduction to reinforcement and control learning, Algorithms of control learning | **3** |

**Lab Work:**

| S. No. | Lab contents | No. of Hours |
|---|---|---|
| **1.** | A small scale gaming application | **8** |
| **2.** | Learn how to automate day-to-day tasks using Python. | **6** |

**Course Outcomes:**

| At the end of the course, students will have: | |
|---|---|
| **1.** | Understand advantages and disadvantages of different machine learning algorithms |
| **2.** | Identify suitability of machine learning algorithms for different domains |

**Bibliography:**


| S. No. | Name of Book/ Authors/ Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | TanejaSheetal, Kumar Naveen, "Python Programming: A modular approach by Pearson", Pearson Education; First edition | **2016** |
| **2.** | Paul Barry, "Head First Python: A Brain-Friendly Guide", Shroff/O'Reilly; Second edition | **2016** |
| **3.** | Tom M. Mitchell, "Machine Learning", McGraw Hill Education; First edition | **2017** |
| **4.** | Yuxi (Hayden) Liu, "Python Machine Learning By Example", PacktPublishing Limited | **2017** |

# Soft Skill & Management

| | | |
|---|---|---|
| **Course Name** | **:** | **Communication Skills (CS)** |
| **Course Code** | **:** | **SSM 5021** |
| **Credits** | **:** | **1.5** |
| **L T P** | **:** | **0-1-4** |
| **Segments** | **:** | **1-3** |

**Total No. Tutorials:- 07**

**Total No. of Lab hours:- 28**

**Course Objectives**:

1. To enhance competence in communication skills: verbal and nonverbal.
2. To provide orientation in technical communication skills: spoken and written.
3. To sensitize students to attitude formation and behavioural skills.

Total No. Tutorials:- 07

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| 1. | **Introduction to Communication Skills, Soft Skills and Interpersonal Communication** | 1 |
| 2. | **Speech:** Structure, Elements, Content, Organization and Delivery J-a-M | 1 |
| 3. | **Writing Skills:** Letters, Minutes of Meeting | 1 |
| 4. | **Technical Report Writing:** Concept & Structure | 1 |
| 5. | **Research Writing:** Concept & Structural Framework | 1 |
| 6. | **Power Point Presentation:** Project Presentation | 1 |
| 7. | **Interviews** | 1 |

**Lab Work**

| S.No. | Lab. Contents | No. of Hours |
|---|---|---|
| 1. | Self- Introduction | 2 |
| 2. | Negotiation Skills & Role Play | 2 |
| 3. | J-a-M Session | 2 |
| 4. | Building Word Power through Reading | 2 |
| 5. | Group Discussion and Case Study | 4 |
| 6. | Writing Skills: Letters, Minutes of Meeting | 2 |
| 7. | Technical Report Writing: Concept & Structure | 4 |
| 8. | Research Writing: Concept & Structural Framework | 4 |
| 9. | Power Point Presentation: Project Presentation | 4 |
| 10. | Interviews | 2 |

**Course Outcomes**

| At the end of the course, students will be able to | |
|---|---|
| 1. | Enhance their competence in communication and technical communication and develop awareness of attitude formation and behavioural appropriateness. |
| 2. | The course will address the gap which exists between employer expectations and student proficiency. |

**Bibliography:**


| S.No. | Book Detail | Year of Publication |
|---|---|---|
| 1. | Technical Communication, Meenakshi Raman and Sangeeta Sharma, Oxford University Press | 2015 |
| 2. | English for Research Paper Writing, Adrian Wallwork, Springer, London | 2011 |
| 3. | English Vocabulary In Use: Advanced+ CD, McCarthy Michael, CUP, Cambridge | 2004 |
| 4. | Advanced English Grammar, Martin Hewings, CUP, Cambridge | 2003 |
| 5. | Study Listening, Lynch Tony, CUP, Cambridge | 2004 |
| 6. | Study Speaking , Anderson Kenneth, CUP, Cambridge | 2010 |
| 7. | Study Reading , Glendenning H. Eric, CUP, Cambridge | 2004 |
| 8. | Study Writing , Lyons Liz Hamp& Ben Heasley, CUP, Cambridge | 2004 |
| 9. | Study skills in English, Michael J. Wallace, CUP, Cambridge | 2004 |

| | | |
|---|---|---|
| **Course Name** | **:** | **Management and Entrepreneurship/ IPR** |
| **Course Code** | **:** | **SSM 5022** |
| **Credits** | **:** | **1** |
| **L T P** | **:** | **0-3-0** |
| **Segments** | **:** | **4-5** |

**Total No. Tutorials:- 14**

**Course Objectives:**

1. The main aim of this course is to make students familiar with the concepts of Management and Entrepreneurship and understand how to develop new start-up and manage it effectively. It also aims to create awareness about the concepts of Innovation, Ideation and IPR.

**Course Contents**:

| S.No. | Course Contents | No. of Tutorials |
|---|---|---|
| 1. | Principles and Functions of Management | 1 |
| 2. | Planning Process - Hypothetical Planning of an Event/Activity | 1 |
| 3. | Form of Organization Structure - Case Study | 1 |
| 4. | Human Resource Planning and Process, Current HR Practices | 2 |
| 5. | Elements of Directing and Effective Control Mechanism<br>Activity: Role Playing/Management Game | 2 |
| 6. | Concepts of Entrepreneurship and Characteristics of Entrepreneurs | 1 |
| 7. | Development Phases of Entrepreneurship<br>-Idea Generation<br>-Project Formulation and Validation<br>-Business plan | 4 |
| 8. | Ecosystem for Entrepreneurship Development and IPR | 2 |

**Course Outcomes**

| At the end of the course: | |
|---|---|
| 1. | The students will learn to develop and manage new project/start-up. |
| 2. | The students will be able to use management skills for success of business venture. |

**Bibliography:**


| S. No. | Book Detail | Year of Publication |
|---|---|---|
| 1 | "Entrepreneurship", TrehanAlpana, Dreamtech Press/Wiley India Publication. | 2018 |
| 2 | "Management Principles and Practice", Srinivasan R. and Chunawalla S.A., Himalaya Publishing House. | 2017 |
| 3 | "Essentials of Management: International and Leadership Perspective", WeihrichH.and Koontz H., 9th Edition, Pubs: McGraw Hill. | 2012 |
| 4 | "The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning. | 2014 |
| 5 | "Principles & Practice of Management", Prasad L.M., 8th Edition, Pubs: Sultan Chand & Sons. | 2015 |
| 6 | "Management: Text and Cases", Rao V.S.P. and Krishna V.H., Pubs: Excel Books. | 2008 |

| | | |
|---|---|---|
| 7 | "Management: Concept, Practice and Cases", Aswathappa K. and GhumanKarminder, Pubs: McGraw Hill Education. | 2010 |
| 8 | "Dynamics of Entrepreneurial Development & Management", Desai V., 5th Edition, Pubs: Himalaya Publishing House. | 2012 |
| 9 | "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Chandra P., 8th Edition, Pubs: McGraw-Hill Education (India). | 2014 |
| 10 | "Entrepreneur's Toolkit", Harvard Business School, Pubs: Harvard University Press. | 2004 |
| 11 | "Essentials of Project Management", Ramakrishna K, Pubs: PHI Learning. | 2010 |
| 12 | Harvard Business Review: Entrepreneur's Handbook | 2018 |
| 13 | WIPO Annual Publications | |

| | | |
|---|---|---|
| **Course Name** | **:** | **Professional Ethics** |
| **Course Code** | **:** | **SSM 5023** |
| **Credits** | **:** | **0.5** |
| **L T P** | **:** | **0-3-0** |
| **Segments** | **:** | **6** |

**Total No. Tutorials:- 07**

**Course Objectives:**

1. The main aim of this course is to provide basic knowledge about ethics, values, norms and standards and their importance in professional life.

**Course Contents:**

| S.No. | Course Contents | No. of Tutorials |
|---|---|---|
| 1. | **Introduction to Ethics:** Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics. | 2 |
| 2. | **Self-Awareness & Self Development:** Concept of Self Awareness – Need, Elements, Self-Assessment – SWOT Analysis, Self-Concepts – Self-Knowledge, Assertiveness and Self-Confidence, Self-Esteem, Concept of Self-Development, Social Intelligence, Emotional Intelligence, Managing Time and Stress, Positive Human Qualities (Self-Efficacy, Empathy, Gratitude, Compassion, Forgiveness and Motivation | 2 |
| 3. | **Ethics and Business:** Concept of Business Ethics – Nature and Objectives.Ethical dilemmas in business ethics. | 1 |
| 4. | **Professionalism in engineering and its relation to ethics:** Ethics in Practice: Professional accountability, Roles of Professionals. | 2 |

**Course Outcomes:**

| At the end of the course: | |
|---|---|
| 1. | The students will be able to distinguish between right and wrong in both personal and professional life. |
| 2. | The students will learn about their strengths, weaknesses, opportunities & threats and work enthusiastically to transform weaknesses into strengths and threats into opportunities. |

**Bibliography:**


| S. No. | Book Detail | Year of Publication |
|---|---|---|
| 1. | "Business Ethics – Text and Cases", Murthy C.S.V., 1st Edition, Pubs: Himalaya Publishing House. | 2014 |
| 2. | "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Leary M.R., 1st Edition, Pubs: Oxford University Press. | 2007 |
| 3. | "Business Ethics", Hartman L.P. and Chatterjee A., 3rd Edition, Pubs: Tata McGraw Hill | 2006 |
| 4. | "Business Ethics and Professional Values", Rao A.B., Pubs: Excel Books | 2006 |

| | | |
|---|---|---|
| 5. | "Business Ethics – Concepts and Cases", Velasquez M.G., 5th Edition, Pubs: Prentice Hall | 2001 |
| 6. | "Issues and Ethics in the Helping Professions", Corey G., Corey M.S. and Callanan P., 8th Edition, Pubs: Brooks/Cole, Cengage Learning | 2010 |
| 7. | "Theories of Personality", Hall C.S., Lindzey D. and Cambell J.B., 4th Edition, Pubs: Hamilton Printing Company | 1997 |

# Program Core

| | | |
|---|---|---|
| **Course Name** | : | **Advanced Reinforced Concrete Structures** |
| **Course Code** | : | **CEM 5017** |
| **Credits** | : | **3** |
| **L T P** | : | **2-0-2** |
| **Segments** | : | **1-6** |

**Total No. of Lectures: 28**
**Total No. of Lab Hours: 28**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To enhance competence in design of advanced reinforced concrete structures. |
| **2.** | To familiarize the students with the concepts of designing concrete mixes using different methods of proportioning and to understand the effects of various parameters. |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Concrete Technology:** Concrete as structural material, strength of concrete and its significance, Strength porosity relationship, Factors effecting compressive strength, Behavior of concrete under stress states, Durability of concrete and its significance, Chloride and Sulphate attack, Alkali aggregate reaction, Carbonation,Corrosion of embedded steel in concrete and concrete deterioration due to corrosion of steel and its preventive measures. | **6** |
| **2.** | **Design of Slender Columns:**Concentrically loaded slender columns, eccentrically loaded slender columns, Slender columns subjected to axial and transverse loads, Structural behavior of columns in braced and unbraced frames, Codal procedure for design of slender columns. | **4** |
| **3.** | **Flat Slabs:**Elements of flat slabs, Codal procedure for design of flat slabs, Behavior of flat slab in shear, One way and two way shear, Equivalent Frame Method, Openings in flat slabs, Effect of pattern loading in flat slabs. | **5** |
| **4.** | **Deep Beams**:General features, Parameter influencing design, Flexural bending and shear stresses in deep beams. Design provisions of IS-456, Checking for local failures,Strut and tie analysis of deep beams, Detailing of reinforcement in deep beams. | **5** |
| **5.** | **Yield Line Analysis*:***Design of slabs of various shapes and having various support conditions using yield line analysis approach. | **4** |
| **6.** | **Design of Beam Column Joints*:***Types of joints, Joints in multi-storeyed buildings, Forces acting on joints, Design of joints for strength, Anchorage requirement in joints and detailing of reinforcement in joints. | **4** |

**Lab Work:**

| S.No. | Lab contents | No. of Hours |
|---|---|---|
| **1.** | Effect of water/cement ratio on workability and strength of concrete | **04** |
| **2.** | Effect of fine aggregate/coarse aggregate ratio on strength and permeability of concrete. | **04** |

| | | |
|---|---|---|
| **3.** | Study of Mix Design Methods using admixtures. | **04** |
| **4.** | Stress- Strain relationship for concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture. | **06** |
| **5.** | Non-Destructive testing of concrete | **04** |
| **6.** | Software applications in design of Reinforced Concrete Structures | **06** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Show competency in design of advanced reinforced concrete structures. |
| **2.** | Design concrete mixes using different methods of proportioning and develop understanding of the effects of various parameters on concrete. |

**Bibliography:**

| S.No | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Advanced R.C.Design, Krishna Raju, CBS Publishers, Hyderabad | 2016 |
| **2.** | Limit State Design, A.K. Jain, Nem Chand & Bros, Roorkee | 2012 |
| **3.** | Concrete Technology, M.S. Shetty, S. Chand & Company, New Delhi | 2015 |
| **4.** | Concrete Manual, M.L Gambhir, Dhanpat Rai &Co,New Delhi | 2014 |
| **5.** | Material Testing Laboratory Manual, Kaushik &Kukreja, Standard Publications, New Delhi | 2010 |
| **6.** | Properties of Concrete, Neville, Pearson Education LimitedLondon | 2012 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Reinforced Concrete Structures, Park and Pauley, Wiley-Interscience Publications, New Jersey | 1975 |
| **2.** | Plain and Reinforced Concrete, Volume I & II, Jain& Jai Krishana,Nem Chand & Bros, Roorkee | 1984 |

**MOOCs on this course are available at:**

1) https://degrees.griffith.edu.au/course/7304ENG

Course: Advanced Reinforced and Pre-stressed Concrete

Professor: Dr Jeung-Hwan Doh, Griffith University, Australia

2) https://onlinecourses.nptel.ac.in/noc17_ce23/preview

Course: Design of Reinforced Concrete Structures

Professor: NirjharDhang, IIT Kharagpur

3) https://freevideolectures.com/course/2686/design-of-reinforced-concrete-structures

| | | |
|---|---|---|
| **Course Name** | : | **Structural Dynamics** |
| **Course Code** | : | **CEM 5027** |
| **Credits** | **:** | **3** |
| **L T P** | **:** | **2-0-2** |
| **Segments** | **:** | **1-6** |

**Total No. of Lectures: 28**
**Total No. of Lab Hours: 28**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To impart the knowledge of dynamic response of structures. |
| **2.** | To illustrate applications of the structural dynamics theory for practical problems. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| **1.** | **Single Degree of Freedom Systems:**Fundamental, Mass spring damper system, Analysis of free vibrations, Response to harmonic loading, periodic loading, Impulsive loading and general dynamic loading. | **5** |
| **2.** | **Multi Degree of Freedom Systems:**Two degree of freedom system – undamped, free & forced. Multidegree of freedom system-undamped, Hozler's method, Stodola's method, Orthogonality condition, Damped system. Dynamic analysis and Response-Modal Analysis, Response spectrum analysis. | **9** |
| **3.** | **Structures with Distributed Mass And Load***:*Axial, shear and transverse vibration due to bending of beams, Uniform shear beam, Beam in bending, Numerical techniques for shear beam, Bending of beams. | **6** |
| **4.** | **Earthquake Motion And Response:**Introduction, Strong motion earthquake, Numerical method for spectra, Elastic spectra, Ground velocity and displacement, Inelastic spectra. | **4** |
| **5.** | **Machine Foundations:** Introduction to Design of machine foundations. | **4** |

-

**Lab Work:**

| Sr.No. | Lab contents | No. of Hours |
|---|---|---|
| **1.** | Free vibrations of single degree of freedom system (SDOF) | **04** |
| **2.** | Forced vibration of single degree of freedom system | **04** |
| **3.** | Impulse response of single degree of freedom system | **04** |
| **4.** | Response spectrum of a linear SDOF oscillation | **04** |
| **5.** | Vibration of multi degree of freedom system | **08** |
| **6.** | Behaviour of rigid blocks, furniture etc in different floors for given earthquake | **04** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Analyze the structures subjected to dynamic loads. |
| **2.** | Develop competence for applying structural dynamics theory to understand seismic response of structures. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Elements of Earthquake Engineering, Jai Krishna &ChanderShekhran, South Asian Publishers, New Delhi | 2014 |
| **2.** | Earthquake Resistant Design,Dowrick, Wiley Interscience Publication, New Jersey | 2009 |
| **3.** | Dynamics of structures, Anil K.Chopra, Pearson Education Limited, London | 2016 |
| **4.** | Dynamic of Structures, Clough and Penzein, McGraw Hill Education, New York | 2003 |

**Classical Books:**

| S. No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Dynamics of Structures, John's Biggs, McGraw Hill Publications, New York | 1965 |

**MOOCs on this course are available at:**

1) https://swayam.gov.in/course/3697-structural-dynamics
   Course: Introduction to structural dynamics
   Professor: Ramancharala Pradeep Kumar, IIIT Hyderabad

2) http://nptel.ac.in/courses/105101006/
   Course: Structural Dynamics
   Professor: P. Banerji , IIT Bombay

3) https://freevideolectures.com/course/3129/structural-dynamics

# Program Elective

| | | |
|---|---|---|
| **Course Name** | : | **High Rise Buildings** |
| **Course Code** | : | **CEM 5131** |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-1-0** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 14**
**Total No. of Tutorials: 07**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To enhance competence in understanding the various structural systems of high rise buildings |
| **2.** | To familiarize the students with the methods of analysis of tall-steel and concrete buildings under various loading conditions. |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Structural Systems:** Structural systems and concepts, Loading: Gravity, wind and earthquake loading. | **3** |
| **2.** | **Approximate Methods of Analysis:** Approximate methods for analysis of Tall buildings, shear-wall frames, Torsion in frames. | **4** |
| **3.** | **Coupled Shear Wall:** Analysis of coupled shear walls. | **3** |
| **4.** | **Advanced Analysis:** Overall buckling analysis of frames, P- delta analysis in steel and concrete buildings using Software. | **4** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Develop competence for selection of suitable structural system for tall buildings. |
| **2.** | Analyze tall buildings under gravity, wind and earthquake loading. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Analysis of Shear walled Buildings, S.M.A.Kazimi, Van Nostrand Reinhold Co., Canada | 1976 |
| **2.** | High Rise Building Structures, Schueller, Wiley IntersciencePublication,New York | 1986 |
| **3.** | Tall Building Structures: Analysis and Design, B. Stafford Smith & A. Coule, Wiley Interscience Publication, New Jersey | 1991 |
| **4.** | Construction Technology for High Rise Buildings, M. Basem, Create Space Independent Publishing Platform | 2014 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Structural Analysis and Design of Tall Buildings, TaranathBungale, McGraw Hill, New York | 1997 |
| **2.** | Advances in Tall Buildings, L.S. Beedle, VMR. | 1986 |

| | | |
|---|---|---|
| **Course Name** | : | **Theory of Plated Structures** |
| **Course Code** | : | **CEM 5132** |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-1-0** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 14**
**Total No. of Tutorials: 07**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To impart knowledge for understanding the structural behaviour of plates and shells. |
| **2.** | To enhance the competence to design plated and shell structures. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| **1.** | **Pure Bending of Plates:**Slope and curvature, Relation between bending moments and curvature, Strain Energy. | **4** |
| **2.** | **Symmetrical Bending Of Circular Plates:** Differential equation in polar coordinates, Uniformly loaded circular plate with or without a hole at the center and with various edge conditions. | **3** |
| **3.** | **Rectangular Plates:**Differential equation of the deflection surface (small deflection theory only). Fourier series expansion for various type of loads, Rectangular plate with various loadings and edge conditions,Navier's and Levy's methods. | **3** |
| **4.** | **Orthotropic Plates:**Differential equation for orthotropic plates. Rigidities for various stiffening systems, Solution for open grids, Navier's solution for orthotropic plates, Working Design of a Coffer slab Construction. | **4** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Understand the concepts of analysis of plated and shell structures. |
| **2.** | Design various types of plated and shell structures. |

**Bibliography:**


| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Theory and analysis of plates,Szilard,R., Prentice Hall, New Jersey | 1973 |
| **2.** | Beams Plates and Shells,Donnel, L.H., McGraw Hill, New York | 1976 |
| **3.** | Design of Shell Roofs,Chatterjee, Chapman & Hall, London | 1988 |
| **4.** | Analysis and design of plated structures, C.M.Wang,Woodwad, New York | 2007 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Theory of Plates &Shells,Timoshenko, McGraw Hill, New York | 1968 |
| **2.** | Shell Roof Analysis, Paduart, A, Cement & Concrete Association | 1966 |

**MOOCs on this course are available at:**

1) https://freevideolectures.com/course/2679/design-of-steel-structures
   Course: Design of steel structures : Theory of plates
   Professor: DamodarMaity, IIT Guwahati

| | | |
|---|---|---|
| **Course Name** | : | **Advanced Concrete Technology** |
| **Course Code** | : | **CEM 5133** |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-1-0** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 14**
**Total No. of Tutorials: 07**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To familiarize the students with latest trends in concrete technology. |
| 2. | To impart knowledge to design various types of concrete mixes. |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Structural Concrete:**High strength concrete, materials for High Strength Concrete, Use of admixtures/super-plasticizers, High Performance Concrete, Polymer Concrete. | **3** |
| **2.** | **Concrete Containing Supplementary Cementitious Material –:** Classification and properties of Fly ash, Reaction mechanism of Fly ash, Properties of Fly ash Concrete, Foam Concrete, Pervious Concrete, Mix Design procedure for Fly ash Concrete, Software application for design of Concrete Mixes, Ready Mix Concrete. | **4** |
| **3.** | **Self-Compacting Concrete:**Self compacting concrete and its properties, Guidelines for mix proportioning of self-compacting concrete | **4** |
| **4.** | **Fiber Reinforced Concrete:**Properties of constituent materials, Mechanics and properties of Fiber Reinforced Concrete, Applications of fiber Reinforced Concrete. | **3** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Understand the behaviour and application of various concretes in construction. |
| **2.** | Design different types of concrete mixes. |

**Bibliography:**

| Sr. No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Concrete Technology, Nevillie, Pearson Education Limited, New Jersey | 2010 |
| 3. | Concrete Technology, M.S. Shetty, S Chand & Company Ltd., New Delhi | 2015 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Fiber Reinforced Concrete,Bala Guru and Shah, McGraw Hill Education, New York | 1992 |
| **2.** | New Concrete Materials - Vol.1, Swami | 1986 |

**MOOCs on this course are available at:**

1) https://onlinecourses.nptel.ac.in/noc18_ce21/preview
   Course: Advanced Concrete Technology
   Professor: Dr Manu Santhanam, IIT Madras

2) https://swayam.gov.in/courses/4667-july-2018-advanced-concrete-technology
   Course: Advanced Concrete Technology
   Professor: Dr Manu Santhanam, IIT Madras

3) https://www.freesharebox.com/mooc/2018-06/584.html
   Course: Concrete Technology
   Professor: SudhirMisra, IIT Kanpur

4) https://freevideolectures.com/course/3357/concrete-technology

| | | |
|---|---|---|
| **Course Name** | : | **Advanced Soil Engineering** |
| **Course Code** | : | **CEM 5134** |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-0-2** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 14**
**Total No. of Lab Hours: 14**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To impart knowledge of engineering properties of various types of soils. |
| **2.** | To impart knowledge of latest trends in soil engineering. |

| S. No. | Course contents | No. of Lectures |
|---|---|---|
| **1.** | **Origin, nature and distribution of soils:** Engineering Behaviour of Soils of India: Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits | **2** |
| **2.** | **Consolidation:** One, two and three dimensional and radial consolidation. Factors affecting shear behaviour. Determination of parameters. Pore-pressure parameters. Unconsolidated Undrained, Consolidated Undrained, Consolidated Drained tests. Total and effective stress paths. | **3** |
| **3.** | **Geosynthetics:** Types and functions; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures,Geosynthetics in Pavements; separations, drainage and filtering in road pavements. | **3** |
| **4.** | **Methods of site investigations:** Direct methods, semi-direct methods and indirect methods. Field tests: In-situ shear test, in-situ permeability test, Standard Penetration Test, Dynamic Cone Penetration Test, Codal provisions. | **3** |
| **5.** | **Slope Stability analysis:** Finite and infinite slopes, limit equilibrium methods. Bishop (Rigorous and Simplified) Method | **3** |

**Lab Work:**

| Sr. No. | Lab contents | No. of Hours |
|---|---|---|
| 1. | Consolidation Test | **06** |
| 2. | Tri-Axial Test (UU, CU & CD) | **06** |
| 3. | Demonstration of Static Penetration Test and Dynamic Cone Penetration Test | **02** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Ascertain the behaviour of soil as a construction material as supporting medium. |
| **2.** | To apply latest trends of soil engineering in construction. |

**Bibliography:**

| Sr.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Soil Mechanics,Lambe and Whitman,WileyInterscience Publication, New Jersey | 2000 |
| **2.** | Reinforced soil and its engineering application, Swami Saran, I.K. International, New Delhi | 2013 |
| **3.** | Physical and geotechnical properties of soils,Bowles, McGraw Hill Education, New York | 1984 |
| **4.** | Design aids in soil mechanics and foundation engineering,KanirajS.K.,McGraw Hill Education, New York | 2017 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Soil Mechanics in Engineering Practice, Terzaghi and Peck, John Wiley and Sons, New Jersey | 1948 |
| **2.** | Soil Engineering, Alam Singh, CBS Publishers, New Delhi | 2009 |

**MOOCs on this course are available at:**

1) http://nptel.ac.in/courses/105104147/
   Course: Geology and Soil Mechanics
   Professor: P. Ghosh,IIT Kanpur

2) https://swayam.gov.in/courses/4386-soil-mechanics-geotechnical-engineering-i
   Course: Soil mechanics/geotechnical engineering I
   Professor: Dilip Kumar Baidya, IITKaharagpur

| | | |
|---|---|---|
| **Course Name** | : | **Pre-stressed Concrete Structures** |
| **Course Code** | : | CEM 5231 |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-1-0** |
| **Segments** | : | **4-6** |

**Total No. of Lectures: 14**
**Total No. of Tutorials: 07**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To familiarize the students with concept of pre-stressed concrete. |
| **2.** | To impart knowledge to design pre-stressed concrete structures. |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Introduction to Prestressing:** Principles of pre-stressing, materials of pre-stressing, pre-stressing systems, losses of prestress | **3** |
| **2.** | **Analysis of Prestress:** Analysis of prestress, Thrust Lines, Cable profile and cable layout, concept of load balancing and stresses in cables. | **4** |
| **3.** | **Anchorage Zone Stresses:** End blocks, Stress distribution in end blocks, Anchorage zone reinforcement. | **3** |
| **4.** | **Prestressed Concrete Beams:** Design of Prestressed concrete beams. | **4** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Understand the behaviour of pre-stressed concrete. |
| **2.** | Design pre-stressed concrete structures. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Design of Prestressed Concrete structures,T.Y. Lin, Wiley Interscience, Publication, New Jersey | 2006 |
| **2.** | Fundamentals of Prestressed Concrete, V. Natarajan, B.I. Publications, New Delhi | 1983 |
| **3.** | Prestressed Concrete, Krishna Raju, McGraw Hill Education, New | 2012 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Prestressed Concrete, G. Magnel, Concrete Publications Limited, London | 1954 |

**MOOCs on this course are available at:**

1) http://nptel.ac.in/courses/105106118/
   Course: PRESTRESSED CONCRETE STRUCTURES
   Professor: Amlan K. Sengupta, PhD PE at IIT Madras

   https://freevideolectures.com/course/94/prestressed-concrete-structures

| | | |
|---|---|---|
| **Course Name** | : | **Wind Engineering** |
| **Course Code** | : | **CEM 5232** |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-1-0** |
| **Segments** | : | **4-6** |

**Total No. of Lectures: 14**
**Total No. of Tutorials: 07**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To familiarize the students with effect of wind loading on various structures. |
| **2.** | To impart knowledge to design structures subjected to wind loading. |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1** | **Introduction to Wind Loading:** Historical background to wind loading, Causes and types of wind, Factors affecting wind loading. | **3** |
| **2** | **Wind Dynamics:** Turbulence characteristics, Bluffbody aerodynamics, Wind pressure and forces on buildings and structures. | **4** |
| **3** | **Computational of Wind Loading:** Introduction to SP-64 and calculation of wind forces using IS-875 (Part-III) | **4** |
| **4** | **Methods of Analysis:** Computational Method for Analysis of Structures subjected to Wind Loading | **3** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Understand the behaviour of structures subjected to wind loads |
| **2.** | Design structures subjected to different wind load conditions. |

**Bibliography:**

| S. No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | An Introduction to Wind Engineering, E. Simiu& R.H Scalan, John Wiley & Sons, New Jersey | 1996 |
| **2.** | Structural Analysis and Design of Tall Buildings, B.S Taranath, CRC press (Taylor & Francis group), Florida, US | 2011 |

| | | |
|---|---|---|
| **Course Name** | : | **Construction Engineering** |
| **Course Code** | : | **CEM 5233** |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-1-0** |
| **Segments** | : | **4-6** |

**Total No. of Lectures: 14**
**Total No. of Tutorials: 07**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To familiarize the students with planning, design and utility services of residential and commercial buildings. |
| **2.** | To impart knowledge of various construction management techniques. |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Architectural planning and design of buildings:** Introduction, smart and green buildings, case studies of specialized buildings.planning, landscaping etc. for the architectural design /development of residential and commercial complexes. | **3** |
| **2.** | **Utility Services in Residential and Commercial buildings:** Sanitation, Water supply, Electrical wiring, Rain water disposal, Lighting and illumination, firefighting, solar energy panels, sensor based security systems, | **3** |
| **3.** | **Air Conditioning & Ventilation:** Natural ventilation, Control cooling systems, Modern systems of air conditioning, Ducting systems, Different mechanical means of air conditioning, central air conditioning system. Working out air conditioning loads for different spaces. | **3** |
| **4.** | **Thermal Insulation:**Behavior of various building materials & thermal conductivity, Thermal insulation for air conditioned interior spaces, | **2** |
| **5.** | **Construction Management Techniques:**Modern construction management techniques, CPM/PERT, PDBM, DCPM etc. Time and cost analysis of CPM/PERT, Resource allocation and updating. Use of software in Construction Engineering | **3** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Designresidential and commercial buildings along with the utility services. |
| **2.** | Apply construction management techniques in the field of construction technology. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Structural Design in Architecture,Salvadori& Levy, Prentice Hall, New Jersey | 1981 |
| **2.** | Structure systems, Heihtich Engle and Salvadiri&Hellet, HatjeCantz, Berlin , Germany | 2001 |
| **3.** | Landscape Architecture,J.O.Simonds, McGraw Hill Education, New York | 2013 |
| **4.** | CPM/PERT, B.C. Punmia, Laxmi Publications Private Ltd., New Delhi | 2005 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Space, time& Architecture, Siegfried Giedion, Harward University Press, Cambridge, US | 1941 |
| **2.** | Network Techniques by Levy and Wiest, Prentice Hall, New Jersey | 1977 |

**MOOCs on this course are available at:**

1) https://www.coursera.org/specializations/construction-management
   course: Construction Project Management
   Professor: Ibrahim Odeh, Columbia University, New York

**2)** http://nptel.ac.in/courses/105103093/2
   Course: Principles of Construction Management
   Professor: SudhirMisra,IITKanpur

| | | |
|---|---|---|
| **Course Name** | : | **Advanced Solid Mechanics.** |
| **Course Code** | : | **CEM 5234** |
| **Credits** | : | **1.5** |
| **L T P** | : | **2-1-0** |
| **Segments** | **:** | **4-6** |

**Total No. of Lectures: 14**
**Total No. of Tutorials: 07**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| **1.** | To impart knowledge regarding elastic and inelastic stress analysis of basic structural elements. |
| **2.** | To impart knowledge for understanding the complex behaviour of structures under various loading conditions |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| **1.** | **Analysis of Stresses:** Basic concepts of the theory of elasticity; theory of stresses; stresses on an arbitrary plane; principal stresses; stress invariants; plane state of stress; equilibrium and boundary conditions. | **2** |
| **2.** | **Analysis of Strains:** Infinitesimal and finite strains; strain-displacement relationships; compatibility conditions; stress strain relationships; plane stress and plane strain. | **3** |
| **3.** | **Yield criteria and Ideally Plastic Solids:** Theories of failure; Ideally Plastic solids | **3** |
| **4.** | **Bending of Beams:** Introduction to Energy methods; Straight Beams and Asymmetrical bending; centre of flexure; shear stresses in thin walled open sections; bending of curved beams. | **3** |
| **5.** | **Torsion:** Torsion of prismatic, circular, elliptical sections. | **3** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| **1.** | Understand elastic and inelastic stress analysis for basic structural elements |
| **2.** | Design different types of concrete mixes. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| **1.** | Theory of Elasticity,S. Timoshenko and J.N. Goodier,McGraw Hill Education, New York | 2001 |
| **2.** | Continuum Mechanics, D.S Chandrasekharaiah and L. Debnath, Prism Books Pvt. Ltd, Bangalore | 1994 |
| **3.** | Advanced solid Mechanics, LS Srinath, McGraw Hill Education, New York | 2010 |
| **4.** | Elastic and Inelastic Stress Analysis,I.H. Shames and F.A. Cozzarellie, Prentice Hall,New Jersey | 1997 |

**MOOCs on this course are available at:**

1) http://nptel.ac.in/downloads/105106049/
   Course: Advanced Solid Mechanics
   Professor: U. Saravanan, Department of Civil, IIT Madras

2) https://www.class-central.com/search?q=solid+mechanics
   Course: Experimental Stress Analysis – An Overview
   Professor: K. Ramesh, IIT Madras

**3)** https://courses.edx.org/courses/course-v1:MITx+3.032.2x_1+3T2016/course/
   Course: Mechanical Behaviour of Materials: Stress Transformations, Beams, Columns

# Engineering Mathematics

## Engineering Mathematics 1 (EM1)

| | | |
|---|---|---|
| **Course Name** | **:** | **FOURIER TRANSFORMS** |
| **Course Code** | **:** | **EMM 5011** |
| **Credits** | **:** | **01** |
| **L T P** | **:** | **2-1-0** |
| **Segments** | **:** | **1-2** |

**Total No. of Lectures– 10, Tutorials -5**

### Course Objectives:

The main Objectives of this course are:

| | |
|---|---|
| **1** | To make the students understand the concept of Fourier transform and be able to compute it for standard examples. |
| **2** | To make the students able to apply Fourier transforms to solve differential equations and partial differential equations. |

### Course contents:

| Sr.No | Course Contents | No. of Lectures |
|---|---|---|
| 1 | **Fourier Transforms:** Fourier Integral formulas, Definition and examples, Basic properties, Fourier cosine and sine transforms and examples, Basic properties of Fourier cosine and sine transforms, Multiple Fourier transforms. | 05 |
| 2 | **Fast Fourier Transforms and Short Term Fourier Transforms:** Definition and examples, Basic properties, Applications. | 05 |

### Course Outcomes:

| At the end of the course, students will be able to: | |
|---|---|
| 1 | Solve differential equations by using Fourier transforms |
| 2 | Solve partial differential equations by using Fourier transforms |
| 3 | Apply FFT and STFT to engineering problems |

### Bibliography:


| S. No. | Name of Book / Authors / Publishers | Year of Publication/ Edition |
|---|---|---|
| 1 | "Integral Transforms and Their Applications", LoknathDebnath, CRC Press, Inc., | 1995. |
| 2 | "Integral Transforms and their Applications", Brian Davies, 3rd Edition, Springer-Verlag, New York,Inc, | 2001 |
| 3 | "Fourier Transform and Its Applications", Ronald N. Bracewell, 2nd Edition, McGraw-Hill Inc.,US, | 1986 |

## Engineering Mathematics 2 (EM2)

| | | |
|---|---|---|
| **Course Name** | **:** | **NUMERICAL METHODS** |
| **Course Code** | **:** | **EMM 5013** |
| **Credits** | **:** | **01** |
| **L T P** | **:** | **2-0-2** |
| **Segments** | **:** | **3-4** |

**Total No. of Lectures – 10, Practical -10**

**Course Objectives:**
The main Objectives of this course are:

| | |
|---|---|
| **1** | To make the students understand the basics of numerical methods. |
| **2** | To make the students able to solve problems on system of linear equations and Interpolation by numerical methods. |

**Course contents:**

| S. No. | Course Contents | No. of Lectures |
|---|---|---|
| 1 | **Error Analysis:** Definition and sources of errors, Propagation of errors, Floating-point arithmetic and rounding errors. | 02 |
| 2 | **Interpolation:** Interpolation using Finite differences, Numerical Differentiation and Numerical integration, Trapezoidal and Simpson's rules. | 04 |
| 3 | **Numerical Solution of Differential Equations:** Picard's method, Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Predictor-Corrector method. | 04 |

**Lab Work:**

| S. No. | Lab. Contents | No. of Hours |
|---|---|---|
| 1. | Solving Interpolation, Numerical Differentiation and Numerical integration problems using Mathematica. | 04 |
| 2. | Solving Differential equations numerically using Mathematica. | 06 |

**Course Outcomes:**

| By the end of the course, the students will be able to solve the following by numerical methods: |
|---|
| 1. Problems on Interpolation<br>2. Problems on Differentiation, Integration.<br>3. Solve differential equations. |

**Bibliography:**


| Sr.No. | Name of Book / Authors / Publishers | Year of Publication/ Edition |
|---|---|---|
| 1 | "Introduction to Numerical Analysis",Atkinson K. E., John Wiley. | 1989 |
| 2 | "Applied Numerical Analysis", Gerald C. F. and Wheatley P. O., Pearson | 2004 |
| 3 | "Numerical Methods for Scientific and Engineering Computation", Jain M. K., Iyengar S.R.K. and Jain R. K., New Age International Publisher. | 2004 |
| 4 | "Elements of Numerical Analysis", Gupta R.S., Macmillan India Ltd . | 2008 |


**E**

## Engineering Mathematics 3 (EM3)

| | | |
|---|---|---|
| **Course Name** | **:** | **OPTIMIZATION TECHNIQUES** |
| **Course Code** | **:** | **EMM 5019** |
| **Credits** | **:** | **01** |
| **L T P** | **:** | **2-0-2** |
| **Segments** | **:** | **5-6** |

**Total No. of Lectures – 10, Practical -10**

**Course Objectives:**

The main Objectives of this course are:

| | |
|---|---|
| **1** | To make the students understand the need of Optimization Techniques and develop the ability to form mathematical model of optimization problems. |
| **2** | To make the students able to identify and solve linear and non-linear models of optimization problems. |

**Course contents:**

| S. No. | Course Contents | No. of Lectures |
|---|---|---|
| 1 | Linear Programming: Formulation, Graphical solution, Simplex method. | 04 |
| 2 | Non Linear Optimization Techniques:<br>Unconstrained problems - Necessary and sufficient conditions for extreme points, Newton's method, Guass- Newton method, Parallel axis method.<br>Constrained problems - Lagrangean method , KKT conditions, Nelder Mead method. | 06 |

**Lab Work:**

| S. No. | Lab. Contents | No. of Hours |
|---|---|---|
| 1. | Solving linear problems using Mathematica/MATLAB. | 04 |
| 2. | Solving non-linear problems using Mathematica/MATLAB. | 06 |

**Course Outcomes:**

| | |
|---|---|
| 1 | The students are able to form mathematical model of optimization problems. |
| 2 | The students are able to distinguish between linear and nonlinear models . |
| 3 | The students are able to solve simple problems using Mathematica/MATLAB |

**Bibliography:**


| S. No. | Name of Book / Authors / Publishers | Year of Publication/ Edition |
|---|---|---|
| 1 | "Operations Research" ,Ravindran , Phillips , and Solberg , 2nd edition, John Wiley & sons . | 2000 |
| 2 | "Engineering Optimization" , S S Rao , 3nd edition, New Age . | 2000 |
| 3 | "Operations Research", Kantiswarup, Gupta P.K. & Sultan Chand & Sons | 2007 |
| 4 | "Operations Research", Sharma S.D., Kedarnath, Ramnath&Company . | 1994 |
| 5 | "Operations Research", Bronson R, Shaum's Outline Series . | 1997 |

# SEMESTER-II

| | | |
|---|---|---|
| **Course Name** | : | **Design of Experiments & Research Methodology** |
| **Course Code** | : | **DRM 5011** |
| **Credits** | : | **3** |
| **L T P** | : | **2-1-0** |
| **Segments** | : | **1-6** |

**Course Objectives**

| **The main Objectives of this course are:** | |
|---|---|
| 1 | To introduce the fundamentals of Statistical techniques, Sampling techniques, and Data collection and their interpretation. |
| 2 | To understand concept of research, need for research, types of research and steps in conducting research. |

**Total No. of contact hour: 42 (L= 28+T=14)**

| S.No. | Course Content | No. of Lectures |
|---|---|---|
| 1 | **Design of Experiment**<br>Principles of Experimental design, sampling methods, probability sampling | **3** |
| 2 | **Modeling**<br>Introduction to modeling, types of models, development of mathematical models | **4** |
| 3 | **Random variables**<br>Random variables and its properties, probability distributions, probabilistic model estimation and its assessment | **6** |
| 4 | **Random Variables Data Analysis**<br>Single and multi variables data analysis, estimation of parameters, splinessmoothing, Residual analysis, Analysis of Variances | **5** |
| 4 | **Random Variates**<br>Simulation, Monte Carlo Method, Queuing Theory, Markovian process | **3** |
| 5 | **Geostatistics**<br>Introduction to Geostatistics, Geostatistical data analysis methods | **3** |
| 6 | **Stochastic Processes**<br>Time series analysis, model identification, forecast and uncertainty analysis | **2** |
| 7 | **Research Report Writing**<br>Research objectives formulation, literature collection, data analysis methods, report writing and conclusions | **2** |

**Course Outcomes**

| At the completion of this course, students will be able to: | |
|---|---|
| 1 | Students will be able to make use of various Research methodologies and its applications in the relevant field of engineering. |
| 2 | Organize and conduct research (advanced project) in a more appropriate manner |

| Bibliography | | |
|---|---|---|
| **S.No.** | **Name of Book/Authors/Publishers** | **Year of Publication/ Reprint** |
| 1 | Probability and Statistics for Engineers and scientists, Walpole, Myers, Myers and Ye, Pearson Education. | 7th edition, 2002 |
| 2 | Statistics in Research, BernandOstle and Richard N.Mensing, Oxford & IBH Pub Co. | 3rd edition, 1975 |
| 3 | Probability and Statistics in Engineering, Hines, Montgomery, Goldsman and Borror, John Wiley & Sons. | 4th edition, 2003 |
| 4 | Experimental design, Theory & application, Federer, Oxford & IBH pub Co. | 1955 |
| 5 | Introduction to probability & statistics for Engineers and scientists, Sheldon M. Ross Elsevier Academic press, California, USA | 2014 |

**MOOCs on this course are available at:**

1. http://professional.mit.edu/programs/short-programs/design-and-analysis-experiments
   By Prof. Paul Berger, MIT Professional Education

2. https://nptel.ac.in/courses/107108011/
   By Prof. AmareshChakrabarti, Indian Institute of Science, Bangalore

# Program Core

| | | |
|---|---|---|
| **Course Name** | : | **Advanced Steel Structures** |
| **Course Code** | : | **CEM 5037** |
| **Credits** | : | **3** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **1-6** |

**Total No. of Lectures: 42**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To impart knowledge for plastic analysis of steel structures. |
| 2. | To strengthen the basic fundamentals of plastic design of steel structures |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| 1. | **Concept of Plastic Design***:* Introduction, Theory of plastic bending, Assumptions, Bending of rectangular section, Plastic hinge, Redistribution of moments, Computation of plastic moment, Shape factor, Overload factor, Method of plastic analysis : Statical Method, Mechanism method, Upper bound, Lower bound and uniqueness theorem, Partial, Complete and over complete failure of indeterminate structures. | **7** |
| 2. | **Plastic Analysis and design of Beams:** Single span and continuous Beam, Moment Balancing Method. | **6** |
| 3. | **Plastic Analysis of Frames:**Plastic analysis and design of portal frames subjected to transverse and lateral loads, Analysis of gable frames, Analysis of multibaymultistoreyed frames. | **8** |
| 4. | **Minimum Weight Design:**Concept, Assumptions, Design of frames with prismatic members, Elements of linear programming and its applications to minimum weight design problems. | **6** |
| 5. | **Deflections:**Assumption, Calculation of deflection at ultimate loads, Deflection at working loads, Rotation capacity. | **4** |
| 6. | **Secondary Design Considerations***:* General, Influence of axial force on the plastic moment, Influence of shear force, Local buckling of flanges and webs, Lateral buckling,General design procedure. | **6** |
| 7 | **Introduction to Light Gauge Steel Structures:** Introduction, types of sections,material, local buckling of thin members, compression members, flexural members, connections. | **5** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| 1. | perform plastic analysis of framed structures |
| 2. | design steel structures using theory of plastic design |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Plastic Design by Neal. | 1977 |
| 2. | Steel Structure- Design and Behaviour Salmon and Johnson Publication Harper And Row. | 1980 |
| 3 | Structural Steel Designer's Hand Book by Merritt. | 2011 |
| 4 | Handbook for Structural Engineers, SP: 6(6)-1972. | 1972 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1 | The steel skeleton Volume I and II, J.F. Baker Publication English Language Book Society. | 1954 |
| 2 | Plastic analysis of steel structures, Hedge G. Philips. | 1959 |
| 3 | Plastic Design of Steel Frames by LYNN.S.Beedle. | 1966 |

**MOOCs on this course are available at:**

1. http://www.nptelvideos.in/2012/11/design-of-steel-structures.html
   ByDr.DamodarMaity,Indian Institute of Technology, Guwahati

2. https://ep.jhu.edu/programs-and-courses/565.620-advanced-steel-design
   By Dr.Wheaton of Whiting School of Engineering, USA

| | | |
|---|---|---|
| **Course Name** | : | **Advanced Structural Analysis** |
| **Course Code** | : | **CEM 5047** |
| **Credits** | : | **3** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **1-6** |

**Total No. of Lectures: 42**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To learn advanced methods of structural analysis and to apply these methods for analysis of indeterminate structures. |
| 2. | To impart preliminary knowledge ofanalysing structures using finite element method. |

**Course Contents:**

| S.No. | Course Contents | No. of Lectures |
|---|---|---|
| 1 | **Stiffness Matrix Method:** Basis of stiffness method, Influence coefficients, Kinematic indeterminacy, Degree of freedom, Action displacement relationship, Matrix approach to stiffness method, Transformation of axes system, Formation of load vectors. | **6** |
| 2 | **Application of stiffness matrix method:** Application of stiffness matrix method to various type of structures e.g. Continuous beams, Trusses, Frames and grids, partially discontinuous structures, yielding of supports, spring supports, Temperature effects. | **14** |
| 3 | **Flexibility Matrix Method*:*** Compatibility equations, Flexibility coefficients, Application of complimentary energy principles, Basis of the method, Application of flexibility matrix method to various types of structures: continuous beams, trusses and frames. | **8** |
| 4 | **Finite Element Method*:*** Introduction to finite element method, Theory of elasticity, Coordinate systems, Rotation of axes, Shape functions, Serendipity, Lagrange and Hermitian family of elements,Rectangular elements in flexure, Rectangular element in plane stress and bending, Triangular elements in plane stress and strain, Elements stiffness matrix and load vector, Numerical integration, Isoparametric elements, , Computer programming concepts. | **14** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| 1. | Toanalyze the complex structures using advanced methods of analysis. |
| 2. | To understand the basic concept of finite element method for analysis of civil engineering structures. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1 | Matrix Analysis of Framed Structures, Gere and Weaver, CBS Piblishers. | 2012 |
| 2 | Analysis of Indeterminate Structures , C.K. Wang, Mc Graw Hill | 1982 |
| 3 | Introduction to Finite Element Method , C.S.Desai and John F. Abel,CBS Publisher | 1998 |
| 4 | Advance Structural Analysis, A.K.Jain, Nem Chand & Bros. | 2015 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1 | Finite Element Methods, Zeiekiwitz and Cheung,Tata McGraw Hill Publishing, Pvt. Ltd. | 1967 |
| 2 | Elasticity ,Tensor, Dyadic and EnggApproache, Pei Chi Chou & Pagano, University Series in Basic Engineering | 1967 |

**MOOCs on this course are available at:**

1. https://nptel.ac.in/courses/105106050/
   By Prof. DevdasMenon,Indian Institute of Technology, Madras

2. https://www.civilax.com/lectures-advanced-structural-analysis/
   By Dr. ShahzadRahmad,University of Engineering and Technology, Peshawar

# Program Elective

| | | |
|---|---|---|
| **Course Name** | : | **Advanced Foundation Engineering** |
| **Course Code** | : | **CEM 5331** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To learn the different types of foundation and their suitability for particular site and structure. |
| 2. | To understand soil-structure interaction and calculation of allowable load and settlement of the foundation |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **Shallow Foundations**:Design considerations- factors of safety (including limit state), allowable settlements, location and depth of foundations, Codal provisions, Consolidation settlement in clays (with correction factors). Immediate settlement. Settlement in sands from N-values, elastic solutions. Static cone tests, Plate load tests. | **6** |
| 2. | **Deep foundations:**Type of Piles. Construction methods. Axial capacity of single piles-static formulae, Skin friction and end bearing in sands and clays. Axial capacity of groups, Codal provisions. Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions. Caissons and Wells. | **5** |
| 3. | **Soil structure interaction:** Introduction to soil-foundation interaction problems, soil behaviour , Foundation behaviour, Interface behaviour, Soil Foundation interaction analysis, Soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour. | **4** |
| 4. | Soil Liquefaction and remedial measures, stone column, vibrfloatation, deep compaction. | **3** |
| 5. | **Foundations in difficult soils:** Expansive soils, chemically aggressive environment, soft soils, fills, regions of subsidence. | **3** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| 1. | Decide the type of foundation required for a particular site and structure. |
| 2. | Make geotechnical design of the foundations for civil engineering structures under varied field conditions. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Foundation Analysis and Design, Joseph E. Bowles, Mc-Graw Hill Publications | 1997 |
| 2. | Design aids in soil mechanics and foundation engineering,Kaniraj S.K., Mc-Graw Hill Publications | 1988 |
| 3. | Pile Foundation Analysis and Design, Poulos H.G. and Davis, E.H., John Wiley,1980. | 1980 |

**MOOCs on this course are available at:**

1. https://nptel.ac.in/courses/105105039/
   By Prof.KousikDeb,Indian Institute of Technology, Kharagpur

2. https://freevideolectures.com/course/2674/foundation-engineering
   By Prof.N.K.Samadhiya,Indian Institute of Technology, Roorkee

3. https://www.surrey.ac.uk/postgraduate/advanced-geotechnical-engineering-msc-2018
   By Prof.S.Bhattacharya,University of Surrey, England

| | | |
|---|---|---|
| **Course Name** | : | **Seismic Design of Structures** |
| **Course Code** | : | **CEM 5332** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To impart knowledge regarding the effects of earthquakes. |
| 2. | To design earthquake resistant RCC structures. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **Earthquakes:** Causes, Magnitude and Intensity, Ground Motions, Site Effects. | **5** |
| 2. | **Response Spectrum:** Construction, Design Response Spectrum. | **4** |
| 3. | **Seismic Resistant Design:** IS Codal Provision related to Seismic Resistant Design, Earthquake Resistant Design of R.C.C Buildings, | **9** |
| 4. | **Shear Wall**: Analysis and Design of Shear walls, Concept of Soft Storey. | **3** |

**Course Outcomes:**

| At the completion of the course, students will have: | |
|---|---|
| 1. | Knowledge of various effects of earthquakes. |
| 2. | Knowledge to design earthquake resistant structures. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Earthquake Resistant Design of Structures, PankajAgarwal and Manish ShriKhande, Prentice- Hall of India, 2007, New Delhi | 2007 |
| 2. | Earthquake Resistant Design of Structures, S K Duggal,Oxford University Press. | 2007 |
| 3. | Introduction to the Theory of Seismology, Bullen K.E., Great Britain at the University Printing houses, Cambridge University Press 1996. | 1996 |

**MOOCs on this course are available at:**

1. https://nptel.ac.in/courses/105102016/
   By Prof.T.K. Datta,Indian Institute of Technology, Delhi
2. https://freevideolectures.com/course/3405/seismic-analysis-of-structures
   By Prof.AshokGupta,Indian Institute of Technology, Delhi

| | | |
|---|---|---|
| **Course Name** | : | **Computer Aided Design** |
| **Course Code** | : | **CEM 5333** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To impart knowledge to develop interactive software for analyzing the structures. |
| 2. | To impart knowledge of application of Artificial Intelligence in civil engineering |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **Programming Using Matrix Methods of Structural Analysis:** Assembly of matrices, Solution of equilibrium equations, Flow charts. | **6** |
| 2. | **Interactive Computer Programming:** Computer programs for design of simple civil engineering structural elements. | **8** |
| 3. | **Artificial Intelligence:**Introduction, development of artificial intelligence, artificial neural networks, application of artificial intelligence in civil Engineering. | **7** |

**Course Outcomes:**

| At the completion of the course, students will have: | |
|---|---|
| 1. | Knowledge to develop computer programmes for analysis and design of civil engineering structures. |
| 2. | Knowledge to apply artificial intelligence in civil engineering |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Principle of Interactive Computer Graphics, William M. Newman And Robert F. Sproul, McGraw Hill | 1979 |
| 2. | Matrix Analysis of Framed Structures, Gere and Weaver, CBS Publishers. | 2012 |
| 3. | Computer Aided Design–Software and Analytical Tools, C.S. Krishnamoorthy, S.Rajeev, A Rajaraman,Narosa Publishing House, New Delhi. | 2001 |
| 4. | CAD/CAM Computer Aided Design and Computer Aided Manufacturing,Mikell P. Groover&Emroy W Zimmers, Prentice Hall | 1984 |

| | | |
|---|---|---|
| **Course Name** | : | **Bridge Engineering** |
| **Course Code** | : | **CEM 5431** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **4-6** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To familiarize with the types, suitability, selection, design criteria of various types of bridges. |
| 2 | To impart knowledge for analysis and design of various types of bridges. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **GeneralBridgeSystems:**Considerations in alignment, Planning, Economic considerations, Aesthetics and selection of type of bridge, Geometrical Proportion, Bridge Hydrology, Scour Depth, Depth of foundation, Estimation of Design Discharge | **3** |
| 2. | **Loading Standards:**Specifications for loading, Rail-cum-Road bridges, Indian Road Congress and Indian Railway loading standards. | **3** |
| 3. | **Design of Bridges:**Reinforced Concrete Bridges, Slab culverts, T-Beam Bridges, Introduction to Box Girder Bridges. | **6** |
| 4. | **Bridge Bearings:** Design of Elastomeric Bearings | **2** |
| 5. | **Design of sub structure –**Introduction to design of Piers and Abutments. | **4** |
| 6. | **Limit State concept for Design of RCC bridges–**Introduction to limit state design of RCC Bridges as per IS Standards | **3** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| 1. | Plan and design the superstructure of RCC bridges. |
| 2. | design the substructure and bearing of the bridge. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Design of Bridges, N.KrishnaRaju, Oxford and IBH Publications | 2006 |
| 2. | Essential of Bridge Engineering, Victor D.J, Oxford & I.B.H. | 2014 |
| 3. | Bridge Superstructure, N. Rajagopalan, Narosa Publishing House | 2006 |
| 4. | Bridge Engineering Handbook, W. F. Chen and L. Duan, CRC press | 2003 |
| 5. | Bridge Deck Analysis, E. J. O'Brien, and D. L. Keogh, Taylor and Francis | 1999 |

| | | |
|---|---|---|
| 6. | Structural Bearings, H. Eggert and W. Kauschke, Ernst &Sohn | 2002 |

**Classical Books:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Design of Prestressed Concrete Structures, T. Y. Lin and N. H. Burns, John Wiley and Sons | 1981 |
| 2. | Bridge Analysis Simplified, B. Bakht and L.G. Jaeger, McGraw Hill | 1987 |
| 3. | Dynamics of Railway Bridges, L. Fryba, Thomas Telford | 1996 |

**MOOCs on this course are available at:**

1. http://enggprog.com/archives/2011/12/25/lectures-on-introduction-to-bridge-engineering
   By Dr. ShahzadRahmad,University of Engineering and Technology, Peshawar

2. https://onlinecourses.nptel.ac.in/noc17_ce24/preview
   By Prof.NirjharDhang,Indian Institute of Technology, Kharagpur

| | | |
|---|---|---|
| **Course Name** | : | **Rehabilitation of Structures** |
| **Course Code** | : | **CEM 5432** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **4-6** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To understand the causes of damage and damage assessment methods of various civil engineering structures. |
| 2. | To retrofit the distressed structures. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **Introduction to Rehabilitation of Structures**: Aging of structures, performance of structures, need for rehabilitation. | **4** |
| 2. | **Damage assessment of structures:**Distress in structures,damage source, cause, effects, case studies, Damage assessment and Evaluation models. | **5** |
| 3. | **Testing methods:**Non Destructive Tests and Core cutting methods. | **4** |
| 4. | **Rehabilitation methods:**Repairand rehabilitation of buildings,Seismic strengthening of structures, use of carbon plates, FRP etc. for retrofitting of structures. | **8** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| 1. | assess the distress in structures. |
| 2. | strengthen the structures using various retrofitting techniques. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Concrete Structures , Materials, Maintenance and Repair, Denison Campbell, Allen and Harold Roper ,Longman Scientific and Technical UK | 1991 |
| 2 | Repair of Concrete Structures,R.T.Allen and S.C.Edwards,Blakie and Sons | 1987 |
| 3. | Maintenance Repair & Rehabilitation & Minor Works of Bridges,P.C.Varghese,PHI Learning Pvt. Ltd. | 2014 |
| 4. | Concrete Technology–Theory and Practice,M.S.Shetty,S.Chand and Company, New Delhi | 1992 |

| | | |
|---|---|---|
| **Course Name** | : | **Liquid Retaining Structures** |
| **Course Code** | : | **CEM 5433** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **4-6** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To impart knowledge regarding the analysis and design of various types of RCC tanks for storage of liquids |
| 2. | To design underground and overhead reservoirs. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **Introduction of Containers:**Types of Tanks, Materials, Types of joints, their spacing and design, Design considerations, Cover requirement. | **4** |
| 2. | **Under Grounds Tanks:** Circular and rectangular tanks, Problem of high ground water table. | **5** |
| 3. | **Over Head Service Reservoir:**Special design considerations, Design requirements of materials, membrane analysis and compatibility analysis of reservoir, complete design and drawing details of an overhead service reservoir. | **9** |
| 4. | **Maintenance of Liquid Retaining Structures:** Maintenance of tanks, Prevention of leakage . | **3** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| 1. | Understand the design concepts of structures for storage of liquids. |
| 2. | Design underground and overhead RCC tanks. |

**Bibliography:**


| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Concrete Structures, Vazirani&Ratwani, Khanna Publishers | 2008 |
| 2. | Reinforced Concrete Structures, I.C.Syal&A.K.Goel, UBS Publisher | 2008 |
| 3. | Advanced R.C.Design, Krishna Raju, CBS Publishers, Hyderabad | 2016 |
| 4. | Limit State Design, A.K. Jain, Nem Chand & Bros, Roorkee | 2012 |


**MOOCs on this course are available at:**

1. https://www.icetraining.org.uk/courses/eurocodes/design-liquid-retaining-structures-eurocode-2By Prof.RobinAtkinson,Institution of Civil Engineers, United Kingdom

# Open Elective

| | | |
|---|---|---|
| **Course Name** | : | **Seismic Design of Structures** |
| **Course Code** | : | **CEO 5003** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **1-3** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To impart knowledge regarding the effects of earthquakes. |
| 2. | To design earthquake resistant RCC structures. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **Earthquakes:** Causes, Magnitude and Intensity, Ground Motions, Site Effects. | **5** |
| 2. | **Response Spectrum:** Construction, Design Response Spectrum. | **4** |
| 3. | **Seismic Resistant Design:** IS Codal Provision related to Seismic Resistant Design, Earthquake Resistant Design of R.C.C Buildings, | **9** |
| 4. | **Shear Wall**: Analysis and Design of Shear walls, Concept of Soft Storey. | **3** |

**Course Outcomes:**

| At the completion of the course, students will have: | |
|---|---|
| 1. | Knowledge of various effects of earthquakes. |
| 2. | Knowledge to design earthquake resistant structures. |

**Bibliography:**

| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Earthquake Resistant Design of Structures, PankajAgarwal and Manish ShriKhande, Prentice- Hall of India, 2007, New Delhi | 2007 |
| 2. | Earthquake Resistant Design of Structures, S K Duggal,Oxford University Press. | 2007 |
| 3. | Introduction to the Theory of Seismology, Bullen K.E., Great Britain at the University Printing houses, Cambridge University Press 1996. | 1996 |

**MOOCs on this course are available at:**

1. https://nptel.ac.in/courses/105102016/
   By Prof.T.K. Datta,Indian Institute of Technology, Delhi
2. https://freevideolectures.com/course/3405/seismic-analysis-of-structures
   By Prof.AshokGupta,Indian Institute of Technology, Delhi

| | | |
|---|---|---|
| **Course Name** | : | **Rehabilitation of Structures** |
| **Course Code** | : | **CEO 5004** |
| **Credits** | : | **1.5** |
| **L T P** | : | **3-0-0** |
| **Segments** | : | **4-6** |

**Total No. of Lectures: 21**

**Course Objectives:**

| The main objectives of the course are: | |
|---|---|
| 1. | To understand the causes of damage and damage assessment methods of various civil engineering structures. |
| 2. | To retrofit the distressed structures. |

**Course Contents:**

| S.No. | Course Contents: | No. of Lectures |
|---|---|---|
| 1. | **Introduction to Rehabilitation of Structures**: Aging of structures, performance of structures, need for rehabilitation. | **4** |
| 2. | **Damage assessment of structures:** Distress in structures, damage source, cause, effects, case studies, Damage assessment and Evaluation models. | **5** |
| 3. | **Testing methods:** Non Destructive Tests and Core cutting methods. | **4** |
| 4. | **Rehabilitation methods:** Repair and rehabilitation of buildings, Seismic strengthening of structures, use of carbon plates, FRP etc. for retrofitting of structures. | **8** |

**Course Outcomes:**

| At the completion of the course, students will be able to: | |
|---|---|
| 1. | assess the distress in structures. |
| 2. | strengthen the structures using various retrofitting techniques. |

**Bibliography:**


| S.No. | Name of Book/Authors/Publisher | Year of Publication/ Reprint |
|---|---|---|
| 1. | Concrete Structures , Materials, Maintenance and Repair, Denison Campbell, Allen and Harold Roper ,Longman Scientific and Technical UK | 1991 |
| 2 | Repair of Concrete Structures,R.T.Allen and S.C.Edwards,Blakie and Sons | 1987 |
| 3. | Maintenance Repair & Rehabilitation & Minor Works of Bridges,P.C.Varghese,PHI Learning Pvt. Ltd. | 2014 |
| 4. | Concrete Technology–Theory and Practice,M.S.Shetty,S.Chand and Company, New Delhi | 1992 |