RAMAIAH
Institute of Technology

# CURRICULUM

**for the Academic year 2019 – 2020**

## CIVIL ENGINEERING

**V & VI SEMESTER B.E**

**RAMAIAH INSTITUTE OF TECHNOLOGY**
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

## About the Institute:

Ramaiah Institute of Technology (RIT) (formerly known as M. S. Ramaiah Institute of Technology) is a self-financing institution established in Bangalore in the year 1962 by the industrialist and philanthropist, Late Dr. M S Ramaiah. The institute is accredited with "A" grade by NAAC in 2014 and all engineering departments offering bachelor degree programs have been accredited by NBA. RIT is one of the few institutes with prescribed faculty student ratio and achieves excellent academic results. The institute was a participant of the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. All the departments have competent faculty, with 100% of them being postgraduates or doctorates. Some of the distinguished features of RIT are: State of the art laboratories, individual computing facility to all faculty members. All research departments are active with sponsored projects and more than 304 scholars are pursuing PhD. The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus. RIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with over 1,35,427 books with subscription to more than 300 International and National Journals. The Digital Library subscribes to several online e-journals like IEEE, JET etc. RIT is a member of DELNET, and AICTE INDEST Consortium. RIT has a modern auditorium, several hi-tech conference halls and all are air-conditioned with video conferencing facilities. It has excellent hostel facilities for boys and girls. RIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association. RIT obtained Academic Autonomy for all its UG and PG programs in the year 2007. As per the National Institutional Ranking Framework, MHRD, Government of India, Ramaiah Institute of Technology has achieved 64$^{th}$ rank in 2019 among the top 100 engineering colleges across India.

## About the Department:

The Department of Civil Engineering was started as the third department in the institute with an intake of 60 students in the year 1971. Structural Engineering was first Post Graduate program started in the year 1984 of the institute with an intake of 10 students. The UG program has been accredited by NBA for four times and recently it was accredited for three years 2017-2020. After obtaining the autonomous status in the year 2007, the department focused towards providing state of the art curriculum development, offering electives of the present day need and techno innovative projects. These initiatives resulted in enhanced performance of the students in terms of increase in placement, increase in the number of students writing competitive examinations and pursuing higher education in the foreign universities.

Further Department of Civil Engineering was recognized as a research centre in the year 1994 leading to PhD/MSc in Civil Engineering under Bangalore University till 1994 and later it was brought under State Technological University VTU. The research centre has attracted 30 PhD research scholars to pursue their degree from this research centre and 15 research scholars have completed PhD degree. The areas of research include Structural Engineering, Transportation Engineering, Geo-Technical Engineering, Water resources Engineering and Environmental Engineering.

The Department has close interaction with number of industries and Government agencies through R&D, and consultancy works. It also has MOU's with industries and other institutes for improved interactions and coordination with outside world

## VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

## MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

- Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
- Establishing research clusters in emerging areas in collaboration with globally reputed organizations
- Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

## QUALITY POLICY

We at M. S. Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

## VISION OF THE DEPARTMENT

To become a premier Department to impart state-of-the-art technical knowledge and professional skills through effective learning process with research ambience to produce global quality Civil Engineers to develop sustainable society.

## MISSION OF THE DEPARTMENT

To transform the young minds into employable professionals by providing contemporary technical knowledge and appropriate professional skills through suitable teaching learning process.

To provide rigorous training and acquaint the students with necessary skills and leadership qualities along with ethical values to address the complex and multi- faceted Civil Engineering Problems.

To provide opportunity to develop their potential by fostering intellectual curiosity to promote them for pursuing higher studies and research through exposure to the modern engineering tools and techno innovative projects.

**PROGRAM EDUCATIONAL OBJECTIVES (PEOs):**

Bachelor of engineering graduates of Civil Engineering program of M S Ramaiah Institute of Technology shall attain the following PEO's within three to four years of graduation.

| | |
|---|---|
| **PEO 1** | To perform well in engineering profession as competent professionals using contemporary technical knowledge and professional skills. **(THEME: Perform well in engineering profession as competent professionals)** |
| **PEO 2** | To pursue higher education and show intellectual curiosity for lifelong learning. **(THEME: Higher education and lifelong learning)** |
| **PEO 3** | To communicate effectively to work in multi-disciplinary environments embedded with ethical values and social responsibilities. **(THEME: Effective communication, leadership and ethical values )** |

**PROGRAM OUTCOMES (POs):**

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

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

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

**PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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

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

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

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

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

**PO10: Communication:** 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 presentations, and give and receive clear instructions.

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

**PO12: Life-long learning:** 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.

**PROGRAM SPECIFIC OUTCOMES (PSOs):**

**PSO1:** Apply the knowledge of basic sciences, geology and environmental science along with the conceptual knowledge of engineering sciences to illustrate the process involved in planning, analysis and design of sustainable civil engineering systems.

**PSO2**: Conduct laboratory experiments/field investigations, and analyze/interpret the experimental results for appropriate conclusions and recommendations to a real-world civil engineering problem with a significant perspective of economy, society and environment.

**PSO3:** Demonstrate professional ethics and implement the principles of project management, business and public policy to lead the project execution as per the design requirement, with the state-of-the-art technology and contemporary skills.

## Curriculum Course Credits Distribution

## Batch 2017-21

| Semester | Humanities & Social Sciences (HSS) | Basic Sciences/ Lab (BS) | Engineering Sciences/ Lab (ES) | Professional Subjects - Core (Hard core, soft core, Lab) (PS-C) | Professional Subjects - Electives (PS-E) | Other Electives (OE) | Project Work (PW) | Internship/other activities (IS/EAC) | Total semester load |
|---|---|---|---|---|---|---|---|---|---|
| First | 4 | 9 | 10 | - | - | - | - | 2 | 25 |
| Second | 2 | 9 | 14 | - | - | - | - | - | 25 |
| Third | - | 4 | - | 22 | - | - | - | - | 26 |
| Fourth | - | - | - | 25 | - | - | - | - | 25 |
| Fifth | 2 | - | - | 21 | 3 | - | - | - | 26 |
| Sixth | - | - | - | 16 | 3 | - | 6 | - | 25 |
| Seventh | - | - | - | 16 | 6 | 3 | - | - | 25 |
| Eighth | - | - | - | - | 4 | - | 13 | 6 | 23 |
| Total | 08 | 22 | 24 | 100 | 16 | 3 | 19 | 8 | 200 |

## SCHEME OF TEACHING
## V SEMESTER

| Sl. No. | Course Code | Course Name | Category | Credits | | | | | Contact Hours |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | S | Total | |
| 1. | CV 51 | Structural Analysis – II | PS-C | 3 | 1 | 0 | 0 | 4 | **56** |
| 2. | CV 52 | Environmental Engineering - II | PS-C | 2 | 0 | 0 | 1 | 3 | **42** |
| 3. | CV 53 | Water Resources Engineering - I | PS-C | 3 | 0 | 0 | 1 | 4 | **56** |
| 4. | CV 54 | Intellectual Property Rights | HSS | 2 | 0 | 0 | 0 | 2 | **28** |
| 5. | CV 55 | Design of RC Elements | PS-C | 3 | 1 | 0 | 0 | 4 | **56** |
| 6. | CVE 56 | Elective - I | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| 7. | CVL 57 | Concrete Technology Lab | PS-C | 0 | 0 | 2 | 0 | 2 | **28** |
| 8. | CVL 58 | Fluid Mechanics Laboratory | PS-C | 0 | 0 | 2 | 0 | 2 | **28** |
| 9. | CVL 59 | Environmental Engineering Lab | PS-C | 0 | 0 | 2 | 0 | 2 | **28** |
| | | | **Total** | 16 | 2 | 6 | 2 | 26 | **364** |

## ELECTIVE SUBJECTS

| Sl. No. | Course Code | Course Name | Category | Credits | | | | | Contact Hours |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | S | Total | |
| I. | CVE 561 | GIS and Remote Sensing | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| II. | CVE 562 | Design of Formwork and Scaffolding | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| III. | CVE 563 | Highway Geometric Design | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| IV. | CVE 564 | Applied Hydraulics | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| V. | CVE 565 | Green Building Technology | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |

## SCHEME OF TEACHING
## VI SEMESTER

| Sl. No. | Course Code | Course Name | Category | Credits | | | | | Contact Hours |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | S | Total | |
| 1. | CV 61 | Design of Structural Steel Elements | PS-C | 3 | 1 | 0 | 0 | 4 | **56** |
| 2. | CV 62 | Geotechnical Engineering - I | PS-C | 3 | 0 | 0 | 1 | 4 | **56** |
| 3. | CV 63 | Water Resources Engg - II | PS-C | 3 | 0 | 0 | 1 | 4 | **56** |
| 4. | CV 64 | Extensive Survey Project | PW | 0 | 0 | 4 | 1 | 5 | **70** |
| 5. | CVE 65 | Elective - II | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| 6. | CVL 66 | Highway Materials Testing Lab | PS-C | 0 | 0 | 2 | 0 | 2 | **28** |
| 7. | CVL 67 | Detailing of RC and Steel Structural Elements | PS-C | 0 | 0 | 2 | 0 | 2 | **28** |
| | | | **Total** | 12 | 1 | 8 | 3 | 24 | **336** |

## ELECTIVE SUBJECTS

| Sl. No. | Course Code | Course Name | Category | Credits | | | | | Contact Hours |
|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | S | Total | |
| I. | CVE 651 | Computational Structural Mechanics | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| II. | CVE 652 | Solid Waste Management | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| III. | CVE 653 | Pavement Materials and Construction | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| IV. | CVE 654 | Ground Water Hydrology | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| V. | CVE 655 | Design of PSC Elements | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |
| VI. | CVE 656 | Design of Sub Structures | PS-E | 3 | 0 | 0 | 0 | 3 | **42** |

**(L= Lecture T=Tutorial P=Practical S= Self Study)**

## STRUCTURAL ANALYSIS-II

**Course Code: CV51** **Credit: 3:1:0:0**
**Contact Hours: 56**

### Course Content:

#### Unit I

**Slope Deflection Method**: Introduction, Sign convention, Development of slope deflection equation, Analysis of continuous beams, Analysis of orthogonal rigid plane frames including sway frames with kinematic indeterminacy $\leq 3$.

#### Unit II

**Moment Distribution Method**: Introduction, Definition of terms, Development of method, Analysis of continuous beams, Analysis of orthogonal rigid plane frames including sway frames with kinematic indeterminacy $\leq .3$.

#### Unit III

**Matrix Method of Analysis (Flexibility method)**: Introduction, Axes and Coordinates, Flexibility matrix, Analysis of continuous beam and plane trusses using elementary approach, Analysis of simple orthogonal rigid frames using elementary approach.

#### Unit IV

**Matrix Method of Analysis (Stiffness Method):** Introduction, Stiffness matrix, Analysis of continuous beam and plane trusses using elementary approach, Analysis of simple orthogonal rigid frames using elementary approach.

#### Unit V

**Plastic Methods of Analysis**: Introduction and Basic concepts of plastic analysis, shape factors of simple sections. Equilibrium and Mechanism methods, Collapse loads for simple and continuous beams.

### Text Books


1. Negi and Jahangir, "Basic Structural Analysis", Tata McGraw Hill, Publication company
2. Gupta SP, GS Pandit and R.Gupta, "Theory of Structures Vol 2", Tata McGgraw Hill Publication company Ltd.

## References


1. J. Sterling Kinney, “Indeterminate structural analysis”, Oxford of IBH Publishing Co.
2. Norris Wilbur JK, “Elementary structural analysis”, Mcgraw Hill International Book edition.
3. Ashok K jain, “Advanced structural analysis”, Nemchand of Bros, Roorkee, India


## Course Outcomes (COs):

At the end of the course, students will be able

1. Analyze the rotation and displacement of continuous beams and frames using slope deflection method.
2. Analyze the continuous beams and frames by Moment Distribution method.
3. Analyze beams, frames and trusses using flexibility method.
4. Analyze beams, frames and trusses using stiffness method.
5. Determine collapse loads on beams using plastic analysis.

# ENVIRONMENTAL ENGINEERING - II

**Course Code: CV52**
**Credit: 2:0:0:1** **Contact Hours: 42**

## Course Content:

### Unit I

**Introduction**: Basic definitions. Need for wastewater collection, conveyance, treatment and disposal, Types of Sewerage Systems. Quantity of sewage. Dry weather flow and factors affecting dry weather flow, flow variations and their effects on design of sewerage system. Computation of design flow. Estimation of storm flow by Rational Method. Time of concentration and return period.

### Unit II

**Design of Sewers:** Hydraulic formulae for velocity, Effects of flow variations on velocity, Self-cleansing and Non-Scouring velocities. Hydraulic Design of circular sewers. Types of sewer materials (concrete, PVC, HDPE, CI and stoneware) used, Advantages and disadvantages of materials, Suitability of sewer materials for different purpose. Laying, joining and testing of sewers

### Unit III

**Sewer appurtenances**: Street inlets, Catch basins, Manhole and Drop Manhole. Analysis of sewage- Physical, Chemical and Biological Characteristics with emphasis on BOD and COD. Concepts of Aerobic and Anaerobic activity. Sampling of wastewater. Problems on BOD. Effluent standards.

### Unit IV

**Treatment of sewage:** Flow diagram of Municipal Sewage Treatment plant. Primary treatment- Screening, Grit chamber and Primary Sedimentation tank. Design circular sedimentation tank. Theory and operation of Trickling Filter and types of Trickling Filters, Design of single stage Trickling Filter. Activated Sludge Process and its modifications. Design aspects of Activated Sludge Process and design of conventional activated sludge process.

### Unit V

**Sludge Digestion**, sludge drying beds, other methods of sludge disposal. Onsite treatment methods. Building Drainage - Principles of plumbing, types and location of different types of traps. Pipes and fittings. System of plumbing- one and two pipe system. Plumbing fixtures-closets and urinals. House drainage plan

**Text Books**


1. Garg. S. K., (2015), "Sewage Disposal and Air Pollution Engineering", Khanna Publishers, New Delhi
2. Punmia. B.C. (2010) and Ashok Jain, "Environmental Engineering II", Lakshmi Publications, New Delhi


**References**


1. "Manual on sewerage and Sewage Treatment", (2012) CPHEEO, Ministry of Urban Development, New Delhi.
2. Metcalf and Eddy Inc., (2004) "Wastewater Engineering – Treatment and Reuse", 4th Edition, Tata McGraw Hill, India,
3. Panchdhari A.C., (2005) "Water supply and Sanitary Installations", New Age International Publishers, New Delhi.


**Course Outcomes (COs):**

At the end of the course, students will be able

1. Describe sewerage and drainage system.
2. Select sewer material, design and construct sewers.
3. Demonstrate different sewer appurtenances and characterize wastewater.
4. Design and develop wastewater treatment facilities.
5. Develop house drainage plans

## WATER RESOURCES ENGINEERING - I

**Course Code: CV53**
**Credit: 3:0:0:1** **Contact Hours: 56**

### Course Content:

#### Unit I

**Precipitation and catchment:** Introduction. Hydrologic cycle, World water budget. Precipitation – Forms, Types, Measurement of precipitation, Hyetograph, Rain gauge network, Mean precipitation over an area, Estimation of missing rainfall data, Double mass curve technique, Return period, Plotting positions, I.D.F. curves, PMP, Problems on frequency analysis. Catchment – definition, stream pattern, description of the basin

#### Unit II

**Abstractions and Runoff:** Introduction. Abstractions – Evaporation, Factors affecting evaporation, Measurement of evaporation using evaporation pans, Methods of reduction of reservoir evaporation, Transpiration, Evapotranspiration, Estimation of evapotranspiration. Infiltration – Infiltration capacity, Infiltration rate, Measurement of infiltration, Infiltration indices. Runoff – Introduction, Types of runoff, Factors affecting runoff, Basin yield, Rainfall-runoff correlation, Estimation of runoff with empirical equations – Dicken's formula, Ryve's formula and Inglis formula.

#### Unit III

**Stream flow and Hydrographs:** Stream – classification of stream, stream gauging, measurement of discharge, stage-discharge relations. Introduction, Hydrograph – Definition, Factors affecting flood hydrograph, Components of a hydrograph, Base flow separation, Effective rainfall, Unit Hydrograph- Definition, Assumptions and Limitations of Unit hydrograph, Derivation of units of hydrograph, Unit hydrograph from complex storms, Unit hydrograph of different durations, S - Curve method.

#### Unit IV

**Irrigation and Water Requirement of Crops:** Introduction. Irrigation – Definition, Necessity and Benefits and ill-effects of irrigation, Types of irrigation systems, Various irrigation methods. Water Requirement of Crops – Classification of soil water, Soil moisture constants, Depth of water applied and Frequency of irrigation, Crop seasons, Crop period and Base period, Duty, Delta, G.C.A., C.C.A., Intensity of irrigation, PET, Irrigation Efficiencies. Irrigation requirements of crops.

## Unit V

**Design of Irrigation Canals:** Introduction. Classification of irrigation canals. Design of Canals – Silt theories, Kennedy's theory, Design procedure by Kennedy's theory, Lacey's theory, Regime channels, Regime conditions, Cross-Section of regime channel, Lacey's regime equations, Comparison between Kennedy's and Lacey's theory, Drawbacks in Lacey's theory. Longitudinal section of a canal, Balancing depth, C/s of an irrigation canal, barrow pit, spoil bank, Berms

### Text Books


1. K. Subramanya, "Engineering Hydrology", Tata McGrawHill
2. P. Jayarami Reddy, "Hydrology", Laxmi Publications New Delhi
3. Punmia et.al., "Irrigation and Water Power Engineering", Laxmi Publications, New Delhi


### References


1. Lingsey, Franzini, "Hydrology for Engineers" McGrawHill
2. P.N Modi, "Irrigation, "Water resources and Water Power Engineering", Standard book house.
3. Lingsey, Franzini, "Water recourses Engineering", McGrawHill


### Course Outcomes (COs):

At the end of the course, students will be able

1. Appraise water resources potential on earth and its data analysis in evaluating extreme hydrological events.
2. Estimate various abstractions from precipitation and thereby computing the runoff.
3. Develop stage discharge relations. Analyze hydrographs and estimate the runoff (volume) and peak flood.
4. State the importance of irrigation, types and methods of irrigation and evaluate water requirements of crops.
5. Apply silt theories and design irrigation canals

# INTELLECTUAL PROPERTY RIGHTS

**Course Code: CV54**
**Credit: 2:0:0:0** **Contact Hours: 28**

## Course Content:

### Unit I

**Introduction to Intellectual Property Rights**: Concept of property, Nature and types of intellectual property, Constitutional aspects of IPR, Commercial exploitation of intellectual property, Intellectual property and economic development, Enforcement of rights and remedies against infringement.

### Unit II

**Patents**: Meaning of patent and its purpose, Object of patent law, Evolution of patent system, Application for patent, Criteria for patentability, Non – patentable inventions, Provisional and complete specification, Publication of the application, Opposition to grant of patent, Grant of patent – priority date, date of patent, date of sealing.

### Unit III

**Rights and Obligations of Patent Holder**: Rights of patent holder - monopoly, assignment, license, Working of patent and compulsory license, Obligations of patent holder, Types of patents, Industrial design - registration, rights, infringement and remedies.

### Unit IV

**Trade Marks**: Features and classification, Rights conferred by registration of trade mark, Marks not registrable, Application and procedure for registration of trademarks - term and renewal, Trademark series, joint and associated trademarks, service mark, collective mark.

### Unit V

**Copy Right**: Evolution of copy right law, Meaning, content and substance of copy right, Ownership, rights and period of copyright, Assignment of copyright and relinquishment, License and compulsory licenses

## Text Books


1. N.K.Acharya, “Intellectual Property Rights”, Asia Law House, Hyderabad.
2. Wadehra B.L, “Intellectual Property Law Handbook”, Universal Law Publishing Co. Ltd., New Delhi.

## References


1. 1 Dr.T.Ramakrishna, “Basic Principles and Acquisition of Intellectual Property Rights”, CIPRA, NLSIU, Bangalore.
2. Dr.T.Ramakrishna, “Ownership and Enforcement of Intellectual Property Rights”, CIPRA, NLSIU, Bangalore.


## Course Outcomes (COs):

At the end of the course, students will be able

1. Define and describe the evolution of IPR globally
2. Describe the specifications and claims with reference to patent
3. Outline the rights and obligations on industrial designs.
4. Summarize the rights and working with reference to trademark
5. Describe the contents and significance of copyrights for new inventions

## DESIGN OF REINFORCED CONCRETE ELEMENTS

**Course Code: CV55**
**Credit: 3:1:0:0** **Contact Hours: 56**

### Course Content:

#### Unit I

**Introduction to limit state design**: 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 and over reinforced sections. Limit state of collapse in flexure of rectangular and flanged sections with examples. Limit state of collapse in shear and torsional strength of sections with examples.

#### Unit II

**Serviceability limit states**: Introduction to working stress method, Elastic behaviour of rectangular section, Under, Balanced and over reinforced sections. Simple Problems on Flexural strength, Deflection and cracking in beams using IS Code provisions. Deflection and cracking–codal provisions, Deflection control in design and problems, Problems on calculations of crack width.

#### Unit III

**Limit state design of beams**: Design of singly Reinforced Beams, Doubly Reinforced Beams and Flanged Beams T and L beams. Types of shear failures – Design for shear strength, Types and design of shear reinforcement. Analysis of Torsional moment – Torsional shear stress, Reinforcement for Torsion.

#### Unit IV

**Limit state design of slabs and stairs**: Introduction to one way and two way slabs, Design of one way cantilever slab, simply supported slab, continuous slab. Design of two way slabs. Introduction to stair cases and design of dog legged stair and open well stair cases, Importance of bond, anchorage, lap length etc.

#### Unit V

**Limit state design of columns and footings**: Design of short axially loaded RC columns with problems, RC Columns with uniaxial moment including Problems, RC Columns with biaxial moments and problems, Design concepts of footing (Limit state), Isolated footings with axial load – square type. Isolated footings with axial load – Rectangular, Isolated footings with axial load – and moment.

***Note: Students have to be taken to construction sites to give the demonstrative examples of structural elements such as columns, beams, slab, staircase, etc,..***

**Text Books**

1. Unnikrishnan Pillai and Devadas Mennon, "Design of Reinforced Concrete Structures" –Tata McGraw Hill Publications.
2. Verghese P C, "Limit State Design Of Reinforced Concrete", Prentice Hall of India, New Delhi

**References**

1. Sinha S N, "Reinforced Concrete Design", Tata McGraw Hill Publications
2. Karve s R & Shah V L, "Limit State Theory And Design Of Reinforced Concrete", Vidyarthi Prakashan, Pune
3. Park and Paulay, "Reinforced Concrete", John Wiley and Sons
4. Punmia B C, Jain A K and Jain A K, "Reinforced Concrete Design", Lakshmi Publications, New Delhi

**Course Outcomes (COs):**

At the end of the course, students will be able

1. Describe and apply limit state design concepts of Reinforced Concrete elements.
2. Compute and demonstrate serviceability criteria of flexural members.
3. Analyze, design and detailing of beams.
4. Analyze, design and detailing of slabs and stairs.
5. Analyze, design and detailing columns and footings.

## GIS & REMOTE SENSING

**Course Code: CVPE561**
**Credit: 3:0:0:0** **Contact Hours: 42**

### Course Content:

#### Unit I

**Principles of Remote sensing**- Interactions between matter and electro-magnetic radiation, Energy interaction in the atmosphere, Energy interactions with the earth's surface- spectral reflectance curves, Aerial Photography, Elements of photogrammetry and Visual interpretation

#### Unit II

**Satellites and Data Products**

Types of sensors- passive sensors and active sensors, Spectrometer, Sensor resolution- spectral, Spatial, radiometric and temporal, Photograph v/s image. Types of platforms- airborne remote sensing. Space borne remote sensing, Multispectral , Thermal and Hyperspectral remote sensing, Microwave remote sensing- SAR and SLR, Laser Altimetry. Image Classification: Supervised, unsupervised. Analysis of hyperspectral data, change detection studies

#### Unit III

**Introduction to Geographic Information System**

Introduction to GIS principles , Raster and Vector-based GIS and data structures, Spatial data sources, Generation of thematic maps, Georeferencing, Digitization ,Data Editing, Edge Matching and Mosaicing. Linking Spatial and Non Spatial Data,

#### Unit IV

**Data formats**, Geo-databases, Database concepts and Database management in GIS, Data manipulations: attribute operations, area/distance calculations and overlay analyses. Map Projections, Surface mapping, Interpolation (including TIN), digital elevation model (DEM), Terrain classification- slope aspect, angle of incidence etc, Varigram and Kriging , Regression and correlation analysis

#### Unit V

**Applications of Remote Sensing and GIS in Civil Engineering**

Applications in Water Resources, Transportation, Environmental Engineering, Urban Landscapes, Vegetation, Soil, Minerals and Geomorphology. GPS - Distance measurement, Area Measurement, Ground truth Radiometer and Hands on experience on Commercial GISsoftware (Arc GIS and ERDAS)

**Text Books**

1. Lillesand T.M., Kiefer. R.W., and Chipman. J.W., "Remote Sensing and Image Interpretation", Wiley Publications
2. Kang-tsung-Chang "Introduction to Geographic Information Systems", TMH Publishers

**References**


1. George Joseph , "Fundamentals of Remote Sensing".
2. J.B. Campbell , "Introduction to Remote Sensing".
3. CP Lo Albert K W Yeung, "Concepts and Techniques of Geographic Information Systems", 2005 Prantice Hall of India.
4. "Geographical Information Systems – Principles and Applications", Volume I edited by David J. Maguire, Micheal F Goodchild and David W Rhind, John Wiley Sons. Inc., New York 1991.


**Course Outcomes (COs):**

At the end of the course, students will be able

1. Describe principles of remote sensing over conventional methods.
2. Classify the various sensors and platforms used in remote sensing process
3. Demonstrate the concept of GIS and its applications
4. Describe data structures and data analysis
5. Illustrate how remote sensing and GIS can be used in various civil engineering applications

## DESIGN OF FORMWORK AND SCAFFOLDING

**Course Code: CVPE562**
**Credit: 3:0:0:0** **Contact Hours: 42**

### Course Content:

#### Unit I

**Form Materials and Pressures On Formwork:** Lumber – Types and Finish. Sheathing boards - Working stresses & Repetitive member stress. Plywood – Types and grades, Textured surfaces and strength, Reconstituted wood. Steel & Aluminum Form lining materials. Hardware and fasteners. Nails in Plywood, Bolts lag screw and connectors. Bolt loads. Pressures on Formwork - Concrete density. Height of discharge. Temperature. Rates of Placin. Consistency of concrete – Live loads and wind pressure. Vibration Hydrostatic Adjustment for non standard condition

#### Unit II

**Shores and Form Design:** Simple wood stresses. Slenderness ratio. Allowable loads. Tubular steel shores & Patented shores. Site Preparation - Size and spacing. Steel Tower Frames. Safety practices. Horizontal shoring for multi-levels. More concentrated shore loads. T-heads, Two tier wood shores, Ellis shores, Dayton sure grip, Baker Roos shores, Safway Symons shores, Beaver Advance shores, Dead shores, Raking and Flying shores. Basic simplification. Beam formulas – Allowable stresses.

#### Unit III

**Planning, Site Equipment and Plant for Form Work:** Overall Planning & Detailed Planning. Standard units & Corner units. Schedule for column formwork. Formwork elements. Planning at Tender stage. Development of basic system. Planning for maximum reuse. Economical form construction. Planning examples – Crane size, effective scheduling estimate, Recheck plan details & Detailing the forms. Crane arrangement. Site layout plan. Transporting plant. Formwork beams, Formwork ties, Wales, Scaffold frames, Form accessories & Vertical transport table form work.

#### Unit IV

Deflection, bending & lateral stability. Shear & Bearing – Examples in wall forms, Slab forms, Beam form – Ties, Anchors and Hangers. Column forms – Examples in each.

## Unit V

**Dome Forms, Tunnel Forms, Slipforms and Safety Practices For Scaffolds:** Shells of translation and revolution – Hemispherical, Parabolic, Barrel vaults, Hypar Shells, Conoidal Shells and Folded plates. Shell form design, Building the form & Placing concrete. Strength requirements – Tunnel forming components, Curb and Invert forms, Arch and Wall forms & Telescopic forms. Concrete placement methods – Cut and Cover construction – Continuous Advancing slope method & Bulk head method . General design considerations influence of placing equipment. Tolerances. Form construction for Shafts. Slipforms – Principles , Types, Advantage & Functions of various components. Planning of Slipform operations – Desirable characteristics of concrete. Common problems faced. Safety in slip forms - Special structures built with Slipform Technique & Codal provisions. Types of scaffolds – Putlog and Independent scaffold, Single pole scaffolds, Fixing ties, Spacing of ties, Plan Bracing, Knots & Safety nets.

### References


1. Robert L. Peurifoy and Garold D. Oberlender, "Formwork for Concrete Structures", Third Edition McGraw-Hill, 1996.
2. Hurd, M.K., "Formwork for Concrete", Special Publication No. 4 Sixth Edition, American Concrete Institute, Detroit, 1995.
3. Michael P. Hurst, "Formwork", Construction Press, London and New York, 1997.
4. Austin, C.K., "Formwork for Concrete", Cleaver – Hume Press Ltd., London 1996.
5. Tudor Dinescu and ConstantinRadulescu, "Slipform Techniques", Abacus Press, Turn Bridge Wells, Kent, 1992.
6. "Guide for Concrete Formwork", American Concrete Institute Detroit, Michigan, 1996.
7. Safety Requirements for Scaffolding", American National Standards Institute, New York, 1994


### Course Outcomes (COs):

Students will be able to:

1. Describe various types of materials and forces acting on form work.
2. Analyze and design the shores and formwork.
3. Provide detailed planning for scaffolding.
4. Analyze the deflection of form work.
5. Analyze and design of various types of shells

# HIGHWAY GEOMETRIC DESIGN

**Course Code: CVPE563**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Importance of Highway Geometric Design**, Elements, Factors affecting, Pavement Surface Characteristics, Camber, Right of Way, Road Margins, Carriageway, Kerbs, Formation & Typical Highway Cross-Sections.

### Unit II

**Sight Distances** - Stopping Sight Distance, Overtaking Sight Distance, sight distance at Uncontrolled Intersections, Design Speed, and Super elevation

### Unit III

**Curve Design-**Horizontal Curves, Extra Widening, Transition Curves, Set-back Distances, Gradients and Grade Compensation, Summit Curves, salient features and geometric standards for hill roads

### Unit IV

**Intersections**- At Grade, manoeuvres and Conflict Areas, Traffic Islands, Intersection Forms, Rural and Urban Road Intersections, Speed change & Right-turn lanes. Channelization, Medians, Rotary Intersection & Mini Round-About Highway Lighting.

### Unit V

**Grade Separated Intersections** – Types of Overpasses and Underpasses, Bus Stops, Pedestrian Facilities. Highway Drainage – surface and Sub-Surface Drainage System & Drainage of Slopes. Road Construction in Water-Logged Areas.

**Text Books**


1. Principle and Practice of Highway Engineering – Kadiyali L R & Lal N B, Khanna Publications, New Delhi.
2. SK Khanna & CEG Justo, "Highway Engineering" –Nem chand & Brothers
3. Relevant IRC Codes

## References


1. Subramanyam. K.P, “Transportation Engineering”, Scitech Publications, Chennai.
2. Khanna SK and Justo CEG, “Highway Material Testing Laboratory Manual”, Nemchand and Bros. Roorkee.
3. Kadiyali L.R, “Highway Engineering”, Khanna Publishers, New Delhi.


## Course Outcomes (COs):

Students will be able to:

1. Describe the various elements of geometric design.
2. Estimate the sight distances for various criteria.
3. Design the horizontal and vertical alignment of roadway.
4. Analyze the suitability of intersections and channelization at traffic systems.
5. Prioritize the suitability of grade separated intersection and design drainage systems

# APPLIED HYDRAULICS

**Course Code: CVPE564**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Boundary Layer Theory and Drag & Lift**: Introduction. Laminar and Turbulent flows. Boundary Layer- Definition, Thickness of B.L, Boundary Layer along a long thin plate and its characteristics, Prandtl's Boundary layer equations, Laminar boundary layer, Turbulent boundary layer. Laminar sub-layer, Separation of boundary layer, Methods of controlling boundary layer. Flow Around Submerged Objects: Introduction. Drag and Lift - Definitions, Types of drag, Dimensional analysis of drag and lift, Drag on a sphere, cylinder, flat plate and airfoil, Lift on a circular cylinder and airfoil.

### Unit II

**Energy and Momentum Principles in Open Channel Flow**: Introduction, Classification of flow in open channels, Types of channels, Velocity distribution in channel section, pressure distribution in open channel, Energy and Momentum principles, Description of specific energy curve, channel transitions, Metering flumes – Venturi flume, Standing wave flume.

### Unit III

**Gradually Varied Flow in Open Channel**: Introduction. Dynamic equations of Gradually Varied Flow, Characteristics of flow profiles, Control sections, Analysis of flow profiles- Gradually Varied Flow computations, Practical applications

### Unit IV

**Rapidly Varied Flow in Open Channels**: Introduction. Hydraulic Jump - Momentum equation for the Jump, Classification of Jumps, characteristics of jump in a rectangular channel, Hydraulic jump as an energy dissipater, Location of the jump. Rapidly Varied Flow computations, Flow over spillways and weirs.

### Unit V

**Unsteady Flow in Open Channel Flow**: Introduction, Dynamic equation for unsteady flow, Monoclinical rising wave, Wave propagation, Surges in open channels, Flood Routing – Channel routing, Muskingum method.

**Text Books**

1. P.N. Modi & S.M.Seth, "Hydraulics and Fluid Mechanics & Hydraulic Machines", Standard Book House New Delhi
2. K. Subramanya, "Flow in Open Channel Flow", Tata McGraw-Hill Publishing Company Ltd.

**References**

1. V.T.Chow, "Open Channel Hydrulics", McGraw Publishing Company Ltd. New York.

**Course Outcomes (COs):**

At the end of the course, students will be able

1. Describe the characteristics of various types of drags and estimating drag and lift forces on different objectives of practical relevance
2. Outline the energy and momentum principles in open channel flow.
3. Apply dynamic equation and develop flow profiles at various control sections.
4. Analyze rapidly varied flow and thereby estimate the hydraulic jump for the design of spillways.
5. Apply dynamic equation of unsteady flow and evaluation of surges and channel routing.

# GREEN BUILDING TECHNOLOGY

**Course Code: CVPE565**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Introduction**. Need for green building- Impact of building industry on energy resources, natural resources and environment. Green building-definition. Principles of green building. Concept of Embodied energy and calculation. Life cycle assessment. Consideration while selecting material and design for longevity.

### Unit II

**Building envelope**- Conventional materials and Use of low energy materials - Base materials for RCC and Steel systems. Alternatives to structural systems, masonry, mortar, plastering, roofing, ceiling, paving, flooring, doors, windows and wood work. Smart materials. Low energy construction- low energy material, locally sourced material and recycled material

### Unit III

**Sustainable siting of building**. Orientation of the building. Use of natural light, solar heat and ventilation. Fenestration and shading. Effective cooling and heating systems-solar passive techniques of heating and cooling in a building design. Methods of minimizing load on Conventional systems-Landscaping, water bodies. Building form-surface to volume ratio

### Unit IV

**Thermal Insulation for roof and walls**. Glazing and shading systems. Building finishes. Effective electrical systems - photovoltaic systems. Efficient HVAC systems. Efficient lighting system- efficient bulbs, occupancy sensor systems and light sensors. Efficient motors. Energy auditing and Certification systems-GRIHA and LEED

### Unit V

**Conserving water in building**- Water efficient fixtures- flow restrictors, sensors, no water fixtures. Alternatives for secondary uses. Rain water harvesting, solar water heaters and solar cooking. Low flush toilets, grey water recycling. Onsite treatment. Eco-friendly toilets. Reducing irrigation water requirements. Vertical farming. Xeriscaping.

## References


1. Prof. Dr. Michael Bauer, Peter Mösle and Dr. Michael Schwarz (2010) "Green Building – Guidebook for Sustainable Architecture" Springer.
2. Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison (2001) "Green Building Handbook" Volume 1-Spon Press.
3. Editor: Mili Majumdar, (2002) "Energy-efficient buildings in India" Tata Energy Research Institute.
4. TERI "Sustainable Building Design Manual- Volume I & II" Tata Energy Research Institute.


## Course Outcomes (COs):

At the end of the course, students will be able

1. Demonstrate the knowledge of green building concepts
2. Analyze different alternative building materials based on specific climate and with environmentally responsibility
3. Demonstrate different green building design techniques using passive techniques.
4. Design the building reducing energy and resource consumption.
5. Demonstrate sustainable water management techniques.

# CONCRETE TECHNOLOGY LAB

**Course Code: CVL57**
**Credit: 0:0:2:0** **Contact Hours: 14**

## Course Content:

### List of Experiments:

1. Test on specific gravity and water absorption of fine and course aggregate.
2. Test on grading analysis of fine and course aggregate.
3. Test on Bulk density of fine, course aggregate and bulking of fine aggregate
4. Test on Specific gravity and fineness of cement
5. Test on Normal consistency and initial and final setting time of cement.
6. Test on Soundness of cement
7. Test on compressive strength of mortar.
8. Mix design of concrete-Fresh concrete: Slump , compaction factor, vee bee test and flow test.
9. Properties of hardened concrete -Compressive strength and flexural strength, Split tensile strength, relation between them and codal provision.
10. Non destructive test on hardened concrete using rebound hammer and pandit

### Text Books


1. M.S Shetty, “Concrete Technology “, S. Chand & Co. Ltd, New Delhi.
2. Mehta P.K, “Properties of Concrete”, Tata McGraw Hill Publications, New Delhi.


### References


1. Neville AM, “Properties of Concrete”, ELBS Publications, London.
2. Relevant BIS codes.


### Course Outcomes (COs):

At the end of the course, students will be able

1. Select appropriate aggregates based on their test results.
2. Characterize cement properties by conducting various tests on cement.
3. Design concrete mixes based on properties of material and evaluate the workability of fresh concrete.
4. Describe mechanical behavior of hardened concrete.
5. Demonstrate use of Non-destructive testing methods on concrete

# FLUID MECHANICS LABORATORY

**Course Code: CVL58**
**Credit: 0:0:2:0** **Contact Hours: 14**

**Course Content:**

**List of Experiments:**

1. Calibration of V- Notch
2. Calibration of Rectangular Notch
3. Calibration of Cipolletti Notch
4. Calibration of Broad Crested Weir
5. Calibration of Ogee Weir
6. Orifice/mouth piece
7. Venturimeter
8. Pipe losses
9. Impact of jet on vanes
10. Centrifugal pump
11. Pelton wheel turbine

**Text Books**


1. P.N. Modi & S.M. Seth, "Hydraulics and Fluid Mechanics", Standard Book House
2. Madan Mohan Das, "Fluid Mechanics and Turbo Machines", PHI Learning Pvt. Ltd. 2011


**References**


1. Streeter, Wylie and Bedford, "Fluid Mechanics", Tata McGraw-hill Edition 2010
2. Subramanya .K, "Fluid Mechanics Through Problems", Tata McGraw-hill Publishing Company


**Course Outcomes (COs):**

At the end of the course, students will be able

1. Demonstrate experiments on flow measuring devices in pipe and calibrate them.
2. Demonstrate experiments on flow measuring devices in open channel and calibrate them.
3. Chart the characteristics of hydraulic machinery for analyzing their performance.
4. Analyze and interpret the result for practical fluid flow problems.
5. Estimate the performance of hydraulic machinery and its suitability.

## ENVIRONMENTAL ENGINEERING LABORATORY

**Course Code: CVL59**
**Credit: 0:0:2:0** **Contact Hours: 14**

### Course Content:

### List of Experiments:

1. Determination of pH, Alkalinity and Acidity
2. Determination of Chlorides, available chlorine in bleaching powder and residual chlorine.
3. Determination of Dissolved Oxygen
4. Determination of BOD.
5. Determination of COD
6. Determination of Turbidity and Jar Test for Optimum Dose of alum.
7. Determination of Iron.
8. Determination of Nitrates/ Fluoride
9. Determination of Solids in Sewage: Total, Suspended, Dissolved, Volatile, fixed and Settle able.
10. Determination of particulates in air using high volume air sampler
11. Determination of noise levels in the locality
12. Visit to sewage treatment plant.

### References


1. 1 Dr R B Kotaiah & N Kumara Swamy "Environmental Engineering Laboratory Manual", Charotar Publishing House, 1994.
2. E W Rice, R B Baird et.al, "Standard Methods for the examination of water and waste water, 22nd Edition" American Water Works Association [2012].
3. IS Standards 2490 – 1974, 3360 -1974, 3307 – 1974.
4. Clair N Sawyer, Perry L McCarty "Chemistry for Environmental Engineering".


### Course Outcomes (COs):

At the end of the course, students will be able

1. Analyze the quality of water and sewage sample.
2. Recommend suitability of tested sample as per the Indian standards for drinking.
3. Identify and choose the water source for water supply schemes.
4. Determine air and noise pollution levels in the surrounding environment
5. Demonstrate working of sewage treatment process

# DESIGN OF STRUCTURAL STEEL ELEMENTS

**Course Code: CV61**
**Credit: 3:1:0:0** **Contact Hours: 56**

## Course Content:

### Unit I

**Bolted Connection:** Introduction, Design Philosophies, Limit State Method, Concepts in design of connections, codal provisions and usage of HSFG bolts. Transfer of forces in bolted connections. Failure of bolted connections, simple and eccentric bolted connections, Prying forces, Beam to beam to column connections.

### Unit II

**Welded Connections:** Concepts in design of connections, Codal provisions, types of welds, Defects in welds, simple and eccentric welded connections, Beam to beam and beam to column connections.

### Unit III

**Tension Members:** Introduction, Types of sections, Grades of steel, Codal provision, shear lag and block shear, Analysis & Design of tension members with different cross sections, Lug angles.

### Unit IV

**Compression Members:** Codal provisions, Slenderness ratio, Analysis and design of simple compression members (angles and I-Sections), built –up cross section Lacings and battens, Column splices, Column bases and Gusseted bases (Bolted and welded connections)

### Unit V

**Flexural Members:** Codal provision, Lateral buckling, Web buckling and crippling, Analysis of laterally restrained and unrestrained beams. Design of restrained simple beams and built-up beams.

## Text Books


1. Subramanian .N, “Design of Steel Structures”, Oxford University Press, New Delhi
2. K.S. Duggal, “Design of Steel Structures”, Tata Mcgraw Hill, New Delhi


## References


1. Gaylord and Gaylord, “Design of Steel Structures”, Mcgraw Hill Publications, New York.
2. Relevant IS Codes: IS800, 2007, “SP:6 (Part I) Structural Engineering Hand Book”, BIS, New Delhi.

**Course Outcomes (COs):**

At the end of the course, students will be able

1. Design of steel elements with different types of bolted connections.
2. Design of welded connections between different elements.
3. Design of tension members with different cross sections.
4. Design of compression members with different cross sections and column bases.
5. Design of beams for all types of boundary conditions

# GEOTECHNICAL ENGINEERING – I

**Course Code: CV62**
**Credit: 3:0:0:1** **Contact Hours: 56**

## Course Content:

### Unit I

**Introduction:** Formation of soils, Phase Diagrams, Definitions of Voids ratio, Porosity, Percentage Air voids, Air content, Degree of saturation, Moisture content, Specific gravity, Bulk density, Dry density, Saturated density, Submerged density and their inter relationships. Problems.

**Index Properties of Soils and their Determination:** Index Properties of soils –Water content, Specific Gravity, Particle size distribution, Relative Density, Consistency limits and indices, in-situ density. Laboratory methods of determination of index properties of soils: Moisture content, Specific Gravity, Particle size distribution by Dry sieve analysis and Hydrometer analysis, In-situ density by core cutter & sand replacement methods, Relative Density, Liquid Limit by Casagrande's method and Cone penetration method, Plastic limit and shrinkage limit determination. Importance of index properties in foundation design.

### Unit II

**Classification of Soils:** Purpose of soil classification, basis for soil classification, Particle size classification - MIT classification and IS classification, Unified soil classification and IS classification – Plasticity chart and its importance, Field identification of soils.

**Soil Water & Permeability:** Free water, held water – adsorbed water & capillary water, Capillary phenomenon, Darcy's law- assumptions and validity, coefficient of permeability and its determination in laboratory, factors affecting permeability, permeability of stratified soils, Seepage velocity, Superficial velocity and coefficient of percolation. Importance of permeability in stability analysis of slopes & earthen dams.

### Unit III

**Stresses in Soils & Seepage Analysis:** Effective stress concept - total pressure, neutral pressure and effective stress, quick sand phenomenon. Laplace's equation, assumptions and limitations, characteristics and uses of flow-nets. Estimation of quantity of seepage for Dams and sheet pile walls. Determination of phreatic line in earth dams with horizontal filter near the toe. Importance of flow-nets & hydraulic gradient in stability analysis of slopes & earthen dams.

**Compaction of Soils:** Definition, Principle of compaction, Standard and Modified proctor's compaction tests, factors affecting compaction, effect of compaction on soil properties, types of field compaction, Field compaction control, Proctor's needle, principles of dynamic compaction & vibro-flotation.

**Unit IV**

**Consolidation of Soils:** Definition, Mass-spring analogy, Terzaghi's one dimensional consolidation theory- assumption and limitations (no derivation),Normally consolidated, under consolidated and over consolidated soils, pre- consolidation pressure and its determination by Casagrande's method. Consolidation characteristics of soil ($C_c$, $a_v$, $m_v$ and $C_v$). Laboratory one dimensional consolidation test for determination of - compression index, and coefficient of consolidation (by square root of time fitting method and logarithm of time fitting method).

**Unit V**

**Shear Strength of Soils:** Concept of shear strength, Mohr's strength theory, Mohr-coulomb theory, conventional and modified failure envelops, Total and effective shear strength parameters, Concept of pore pressure, Sensitivity and Thixotropy of clay. Determination of shear parameters using - Direct shear test, Unconfined compression test and Triaxial compression test; Shear strength tests under different drainage conditions, importance of pore pressure & shear strength in geotechnical applications.

**Text Books**


1. Ramamurthy T.N. & Sitharam T.G. (2010), "Geotechnical Engineering", S. Chand & Company, NewDelhi.
2. Gopal Ranjan and Rao A.S.R. (2000), " Basic and Applied Soil Mechanics", New Age International (P) Ltd., New Delhi.


**References**


1. Alam Singh and Chowdhary G.R. (1994), "Soil Engineering in Theory and Practice"' CBS Publishers and Distributors Ltd., New Delhi.
2. Murthy V.N.S. (1996) "Soil Mechanics and Foundation Engineering", 4th Edition, UBS Publishers and Distributors, New Delhi.

**Course Outcomes (COs):**

At the end of the course, students will be able

1. Describe the physical properties of the soils and their significance in foundations design.
2. Classify the soil, evaluate the permeability of soil and its importance in stability analysis of earthen structures.
3. Analyze the seepage flow & estimate the compaction characteristics.
4. Evaluate the settlements study characteristics of soils and their significance.
5. Appraise the shear parameters of soils for foundations

# WATER RESOURCES ENGINEERING – II

**Course Code: CV63**
**Credit: 3:0:0:1** **Contact Hours: 56**

## Course Content:

### Unit I

**Canal Regulation and C/s drainage works:** Canal Regulation - Canal Fall, Necessity and location of canal fall, Types of falls, Hydraulic design principles for Notch type and Sarda type of Drop. Canal Regulators – Cross Regulator, Head Regulator, Functions of Regulators. Cross-Drainage Works – Types of Cross-Drainage Works, Classification of Aqueducts and Syphon Aqueducts, Factors affecting suitability of Aqueduct and Syphon Aqueduct. Features of design of C-D Works. River Training works

### Unit II

**Groundwater Hydrology:** Introduction. Occurrence and movement of ground water – Vertical distribution of groundwater, Aquifers, Specific retention, Specific yield, Darcy's Law, Hydraulic conductivity, Transmissivity. Well Hydraulics - Steady-radial flow into a confined aquifer, Thiem's equation, Steady-radial flow into an unconfined aquifer. Groundwater recourses of India, Artificial recharge. Well irrigation: Advantages and disadvantages, Tube wells – types, methods for drilling, yield, problems

### Unit III

**Head Works** :Introduction, Types of headworks, Components of Diversion Head Works, Weir and Barrages, Theories of Seepage – Design of Impervious floor using Bligh's theory, Introduction to Khosla's theory. Design of Vertical Drop weir. Storage headworks-Dams, Classification and Selection of site for a dam, Types of Earthen dams, Causes of failure of Earthen dams.

### Unit IV

**Gravity Dams:** Gravity Dam – Forces acting on a gravity dam, Vertical stress at the base of the dam & Middle-third rule, Elementary profile of a gravity dam, Practical profile of a gravity dam, Design of dam by Gravity method, Joints, Keys, Water stops and Galleries. Spillways – Essential requirements of a spillway, Spillway capacity, Types of spillways. Stilling basins.

## Unit V

**Flood Estimation and Reservoir Planning:** Introduction. Floods – Flood estimation, Rational method, PMF, Levees and flood walls. Reservoir Planning- Types of reservoirs, Investigations for reservoir planning, Selection of site for a reservoir, Zones of storage in a reservoir, Reservoir yield, Mass curve and Demand curve, determination of reservoir capacity using mass curve, Flood routing – reservoir routing by ISD method, Reservoir losses, Useful life of a reservoir, numerical problems. Principles of Sediment transportation, Water Resources development in India and Inter-state water disputes

### Text Books


1. Modi.P.N, "Irrigation water resources and water power engineering.", Standard Book House, New Delhi.
2. Garg SK," Irrigation Engineering and Hydraulic Structures", Khanna Publishers, New Delhi.
3. K. Subramanya, Engineering Hydrology, Tata McGrawHill


### References


1. P. Jayarami Reddy, "Hydrology", Laxmi Pulications.
2. Punmia BC et.al., "Irrigation and Water Power Engineering", Laxmi Publications.
3. Shyamal K. Majumdar, "Irrigation Engineering ", McGraw-Hill Publisher


### Course Outcomes (COs):

At the end of the course, students will be able

1. Design various types of canal regulation and C/D works
2. Evaluate ground water resources and response of aquifers for various discharge and recharge conditions
3. Enumerate various types of head works and illustrate their functional requirements
4. Analyze various forces encountered in gravity dams and thereby the design of dams
5. Estimate the floods and design the reservoir systems

## EXTENSIVE SURVEY PROJECT

**Course Code: CV64**
**Credit: 0:0:4:1** **Contact Hours: 70**

### Course Content:

An extensive survey training involving investigation and design of the following projects is to be conducted for 2 weeks (14 days). The student shall submit a project report consisting of designs and drawings.

1. **General instructions**: Reconnaissance of the sites
2. **New Tank Project**: The work shall consist of
   i. Alignment of center line of the proposed bund, Longitudinal and cross sections of the center line.
   ii. Capacity surveys.
   iii. Details at Waste weir and sluice points.
   iv. Canal alignment.
3. **Restoration of an Existing Tank**: The work shall consist of:
   i. Alignment of centre line of the existing bund, Longitudinal and Cross sections along the CL.
   ii. Capacity surveys, Details at sluice and waste weir.
4. **Water Supply and Sanitary Project**: Examination of sources of water supply, Calculation of quantity of water required based on existing and projected population. Preparation of village map by any suitable method of surveying, location of sites for ground level and overhead tanks underground drainage system surveys for laying the sewers.
5. **Highway Project**: Preliminary and detailed investigations to align a new road (min. 1 to 1.5 km stretch) between two obligatory points. The investigations shall consist of topographic surveying of strip of land for considering alternate routes and for final alignment. Report should justify the selected alignment with details of all geometric designs for traffic and design speed assumed. Drawing shall include key plan initial alignment, final alignment, longitudinal section along final alignment, typical cross sections of road.

### Course Outcomes (COs):

The students will be able to carry out survey field work and design & develop the drawings of:

1. The components of a proposed new tank
2. Canal cross-sections, canal regulation and cross-drainage works
3. Redesign of the tank bund, surplus weir and increase in the reservoir capacity.
4. Comprehensive water supply and sewerage system for a specified community
5. Alignment and realignment of Roads

# COMPUTATIONAL STRUCTURAL MECHANICS

**Course Code: CVPE 651**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Introduction:** Structural systems, Geometrical and material nonlinearities. Static and Kinematic indeterminacy. Concepts of stiffness and flexibility. Flexibility and stiffness matrices of truss and beam elements. Energy concepts- Principle of minimum potential energy and minimum complementary energy

### Unit II

**Element Flexibility Method**: Transformation of system forces to element forces in flexibility method. Assembly of structure flexibility matrix in element flexibility method, Flexibility method applied to trusses, continuous beams and rigid frames.

### Unit III

**Element Stiffness Method**: Transformation from system forces to element forces in stiffness method, Assembly of structure stiffness matrix in element stiffness method. Stiffness method applied to trusses, continuous beams and rigid frames.

### Unit IV

**Direct Stiffness method**: Local and Global coordinate systems, Stiffness matrices of truss and beam elements in global coordinates, Analysis of trusses and beams by Direct Stiffness method

### Unit V

**Storage Techniques**: Half band, skyline storage, Equation solvers, Frontal solvers, Bandwidth consideration, Algorithms and flow charts, Solution of equations, Uses of commercial packages

**Text Books**


1. Weaver W and Gere J H, "Matrix Analysis of Framed Structures", CBS Publications, New Delhi
2. Rajasekaran S, "Computational Structural Mechanics ", PHI, New Delhi

## References


1. Pundit and Guptha, “Theory of Structures”, Vol II, TMH Publications, New Delhi
2. A K Jain, “Advanced Structural Analysis”, Nemchand Publications, Roorkee
3. C S Reddy, ‘Basic Structural Analysis“, TMH Publications, New Delhi


## Course Outcomes (COs):

At the end of the course, students will be able

1. Describe structural systems and application of the concepts of flexibility and stiffness matrices
2. Adopt flexibility matrices to solve problems in trusses, beams, rigid frames and grids
3. Adopt stiffness matrices to solve problems in trusses, beams, rigid frames and grids
4. Adopt direct stiffness methods to solve problems in trusses, beams, rigid frames and grids
5. Describe various storage schemes and standard commercial packages

# SOLID WASTE MANAGEMENT

**Course Code: CVPE 652**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Introduction to Solid Wastes**: Definition of solid wastes, classification and characteristics of solid wastes, Municipal Solid Waste (Management and Handling) Rules, Biomedical Waste Handling Rules and Recycled Plastic usage Rules

### Unit II

**Collection of Solid Waste**: Systems of collection of solid wastes, transfer stations, collection equipments, route optimization techniques and numerical problems on route optimization, processing techniques of solid wastes (principle of operation and function only).

### Unit III

**Composting**: Composting, factors affecting composting process, aerobic and anaerobic composting, Indore and Bangalore method of composting, mechanical composting process, vermicomposting

### Unit IV

**Landfills**: Sanitary landfilling, trench method, area method, ramp method and pit method, factors considered for a landfill site selection, cell design, leachate collection systems, control of gas movement and gas recovery systems

### Unit V

**Incineration**: Incineration process, factors affecting incineration process, air pollution prevention in incinerators, pyrolysis process, plastic waste, biomedical waste and its Impact on health, industrial solid waste recycling and recovery-electronic industry, sugar industry and thermal power plants.

**Text Books**


1. George Tchobanoglouset.al., "Integrated Solid Waste Management", Mc-Graw-Hill, Inc. New York, 1993.
2. Howard S.Peavyet.al., "Environmental Engineering", Mc-Graw-Hill Book Company, New York, 1985

## References


1. A.D. Bhide and B.B.Sudareshan, “Solid Waste management in Developing Countries”, NEERI, Nagpur 1983.
2. S.K Garg “Environmental Engineering (Vol II)” Khanna Publishres, New Delhi 2009.
3. Robert A. Corbit, “Standard Handbook of Environmental Engineering”, Mcgraw Hill Inc, New Delhi, 1990.
4. P. AarneVesilind, William Worrel and Reinhart, “Solid Waste Engineering”, Thomson Brooks, Cole.
5. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Govt. of India, 2000.
6. Management and Handling Rules for Municipal Solid Waste and Biomedical Waste and Plastic Waste, MOEF publications


## Course Outcomes (COs):

At the end of the course, students will be able

1. Describe the components of solid waste management and the laws governing it.
2. Prioritize the solid waste processing methods and analyze collection systems to propose optimized routes for waste collection.
3. Implement and control the composting process for treatment of organic fraction of solid waste.
4. Design of sanitary landfills and control their conditions of operation and maintenance.
5. Evaluate the conditions of operation and maintenance of incinerators. Identify the waste recovery systems and impacts of plastic waste on environment.

# PAVEMENT MATERIALS AND CONSTRUCTION

**Course Code: CVPE 653**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Aggregates** - origin, classification, requirements, properties and tests on road aggregates, concepts of size and gradation, design gradation, maximum aggregate size, aggregate blending to meet specifications. Bitumen and Tar - origin, preparation, properties and chemical constituents of bituminous road binders, requirements.

### Unit II

**Binders-**Bituminous Emulsions, Cutbacks and Modified binders– preparation, characteristics, uses and tests. Bituminous Mixes – mechanical properties, design methods using Rothfutch's method and specifications for voids in mineral aggregates, voids in total mix, density, flow, stability, percentage voids filled with bitumen.

### Unit III

**Equipment in highway construction –**various types of equipment for excavation, grading and compaction – their working principle, advantages and limitations. Special equipment for bituminous and cement concrete pavement and stabilized soil road construction.

### Unit IV

**Subgrade** – functions, requirements and tests, earthwork grading and construction of embankments and cuts for roads. Preparation of subgrade, quality control tests. Base course and sub-base course layers – functions, requirements, types, specifications, construction methods, quality control tests.

### Unit V

**Pavement Construction:** Flexible pavements – specifications of materials, construction method and field control checks for various types of flexible pavement layers. Cement concrete pavements – specifications and method of cement concrete pavement construction, quality control tests, construction of various types of joints

## Text Books


1. Khanna SK and Justo CEG, "Highway Engineering", Nem Chand and Bros, Roorkee.
2. Sharma BC, "Construction Equipment and Its Management", Khanna Publishers

## References


1. Bituminous Materials in Road construction, RRL, DSIR, HMSO Publications.
2. “Soil Mechanics for Road Engineers”, HMSO Publications.
3. Relevant IRC Codes and MoRT&H Specifications.


## Course Outcomes (COs):

At the end of the course, students will be able

1. Characterize materials for pavement construction based on MORTH specifications.
2. Design bituminous mixes.
3. Determine usage of equipment’s for pavement construction.
4. Adopt construction techniques, specifications and quality control for pavement layers.
5. Compare construction procedure and quality checks for pavement systems.

# GROUND WATER HYDROLOGY

**Course Code: CVPE 654**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Occurrence and Movement of Groundwater:** Introduction. Groundwater in the hydrologic cycle. Influent and effluent streams. Occurrence of groundwater-origin of groundwater, geologic formations as aquifers, groundwater basins, springs. Groundwater resources and groundwater potential in India. Groundwater Flow – Darcy's law, permeability, hydraulic conductivity, transmissivity, Sp. Yield, Sp. Retention. General Flow equations – three dimensional flow equation, Laplace equation, flownet analysis

### Unit II

**Well Hydraulics:** Introduction .Flow into a well. Steady Radial flow into a well-Unconfined aquifer and confined aquifer (Thiem equation). Unsteady Radial flow into a well – Theis method, Chow's method. Well flow near aquifer boundaries – image wells, recharge boundary, spacing of tube wells, method of images. Multiple well systems. Types of wells

### Unit III

**Water Wells:** Introduction. Types of wells and methods of construction. Comparison between open wells and bore wells. Design of water well – well diameter, well depth, well screen. Well completion. Collector wells. Infiltation galleries. Well development. Tube well design. Well yield. Well performance test. Pumping equipment. Maintenance and repair of wells

### Unit IV

**Groundwater Development and Management:** Introduction. Geomorphic and geologic controls on groundwater. Safe yield and overdraft. Factors governing safe yield. Equation of hydrologic equilibrium. Land subsidence due to groundwater withdrawals. Water logging – prevention and control of water logging, spacing of drain tiles. Conjunctive use. Artificial recharge.

### Unit V

**Quality of Groundwater:** Introduction. Sources of salinity. Groundwater samples. Measures of water quality – chemical quality, physical quality, bacterial quality. Quality criteria for groundwater use. Groundwater pollution. Applications of water- quality data for quantitative assessments. Sea water intrusion.

**Text Books**

1. H.M.Raghunath, “Ground Water”, New Age International Publishers- 2007
2. K R Karanth, “Groundwater Assessment Development and Management”, Tata McGraw – Hill Publishing Company Limited, New Delhi- 2008.

**References**

1. D.K.Todd, “Groundwater Hydrology”, John Wiley & Sons, Inc.-2003.

**Course Outcomes (COs):**

At the end of the course, students will be able

1. Evaluate the groundwater resources and aquifer characteristics.
2. Analyze well hydraulics and design the spacing of pumping wells.
3. Design of water well for different discharge and recharge conditions.
4. Enumerate various methods of groundwater development and management.
5. Describe the quality of groundwater, sources of pollution and their remedial measures.

# DESIGN OF PSC ELEMENTS

**Course Code: CVPE 655**
**Credit: 3:0:0:0** **Contact Hours: 42**

**Course Content:**

**Unit I**

**Materials, Basic Principles Of Pre - Stressing & Analysis of Sections For Flexure**: High strength concrete and steel, Stress-Strain characteristics and properties, Pre-tensioning and Post-tensioning systems with end anchorages, Stresses in concrete due to pre-stress and loads for different types of cross sections, stresses in steel due to loads, Cable profiles, Load balancing concept, Centre of Thrust.

**Unit II**

**Losses of Pre-Stress & Deflections**: Various losses encountered in pre-tensioning and post tensioning methods, determination of jacking force, Deflections of pre-stressed members, Short term and long term deflections, Elastic deflections under transfer loads and due to different cable profiles. Deflections limits as per IS 1343. Effect of creep on deflection, methods of reducing deflection. Limit state of serviceability, and control of deflections, crack widths

**Unit III**

**Limit State of Collapse**: Flexure and Shear - IS code recommendations, Calculation of principal tensile stress, Ultimate flexural strength of sections, shear resistance of sections, shear reinforcement.

**Unit IV**

**Design of End Blocks**: Transmission of prestress in pretensioned members, transmission length, Anchorage stress in post-tensioned members. Bearing stress and bursting tensile force, stresses in end blocks, IS code method, provision for the design of end block reinforcement.

**Unit V**

**Design of Beams:** Design of pre-tensioned and post-tensioned sections. Permissible stress, design of pre - stressing force and eccentricity, limiting zone of pre-stressing force, cable profile

**Text Books**


1. Krishna Raju N, “Pre - stressed Concrete”, Tata Mcgraw Hill, New Delhi
2. Rajagopalan N, “Pre - stressed Concrete”, Narosa Publishing House, New Delhi

## References


1. Lin T Y and Burns N H, “Design of Pre - stressed Concrete Structures” , John Wiley and Sons, New York
2. Pundit G S and Gupta S P, “Pre - stressed Concrete”, C B S Publishers, New Delhi


## Course Outcomes (COs):

At the end of the course, students will be able

1. Describe the principle of PSC and role of high strength concrete and steel
2. Enumerate various losses in PSC. Analyze of deflection of PSC elements under limit state serviceability.
3. Evaluate the ultimate flexural and shear strength for design requirements.
4. Analyze the end block and design as per I.S code
5. Design the beam sections.

# DESIGN OF SUB-STRUCTURES

**Course Code: CVPE 656**
**Credit: 3:0:0:0** **Contact Hours: 42**

## Course Content:

### Unit I

**Classification of foundation systems**- General requirement of foundations, Selection of foundations, Computation of Loads & Design concepts. Shallow Foundations - Bearing capacity failures, Bearing capacity formulae & factors, Factor of safety, Selection of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & c- $\phi$ soils, Footings on layered soils and sloping ground, Design for Eccentric Loads or Moment

### Unit II

**Combined footings**- (rectangular & trapezoidal) & strap footings. Soil-structure interaction effects & general concepts of structural design. Types of rafts- bearing capacity & settlements of foundation, Rigid method only

### Unit III

**Deep foundations** - Load Transfer in Deep Foundations. Types of Deep Foundations, Ultimate bearing capacity of different types of piles in different soil conditions, laterally loaded piles, tension piles & batter piles. Load testing of piles.

### Unit IV

**Pile groups-** Bearing capacity, settlement, uplift capacity & load distribution between piles. Proportioning and design concepts of pile cap

### Unit V

**Foundations for tower structures-**Introduction- Forces on tower foundations, Selection of foundation type. Stability and design considerations. Retaining walls – analysis and design.

**Text Books**


1. Swami Saran – "Analysis & Design of Substructures", Oxford & IBH Pub. Co. Pvt. Ltd., 1998.
2. Nainan P Kurian – "Design of Foundation Systems", Narosa Publishing House, 1992

## References


1. R.B. Peck, W.E. Hanson & T.H. Thornburn – "Foundation Engineering", Wiley Eastern Ltd., Second Edition, 1984.
2. Joseph E. Bowles – "Foundation Analysis and Design", McGraw-Hill Int. Editions, Fifth Ed.,
3. W.C. Teng – "Foundation Design", Prentice Hall of India Pvt. Ltd., 1983.
4. Bureau of Indian Standards codes: IS-1498, IS-1892, IS-1904, IS-6403, IS-8009, IS-2950, IS-11089, IS-11233, IS-2911, IS - 802 and all other relevant codes.


## Course Outcomes (COs):

At the end of the course, students will be able

1. Analyze the field data and assess the capacity of soils to support the foundations of structures.
2. Design the different types of shallow foundations based on the soil characteristics.
3. Design the pile foundations in different load and soil conditions.
4. Design the pile group and pile cap based on the bearing capacity and settlement analysis.
5. Analyze and design different tower foundations and retaining walls

# HIGHWAY MATERIALS TESTING LABORATORY

**Course Code: CVL 66**
**Credit: 0:0:2:0** **Contact Hours: 14**

**Course Content:**

**List of Experiments:**

1. Tests on Aggregates:
   i. Aggregate Crushing Value Test
   ii. Los Angeles Abrasion Test
   iii. Aggregate Impact Test
   iv. Shape tests (Flaky, Elongation, Combined Index, Angularity number)
   v. Specific gravity and water Absorption Test
2. Tests on Bituminous Materials and Mixes:
   i. Specific Gravity Test,
   ii. Penetration Test,
   iii. Ductility Test,
   iv. Softening point Test,
   v. Flash and fire point Tests,
   vi. Viscosity Test
   vii. Marshall Stability tests
3. California Bearing Ratio test on subgrade soil
4. Traffic studies: Volume and speed studies.
5. Wet Sieve Analysis

**References**


1. Relevant IS Codes and IRC Codes.
2. S.K Khanna, C.E.G.Justo, and A.Veeraragavan, "Highway Material and Pavement Testing Laboratory Manual" Revised 5th Edition 2009, Nemi Chand & Bros.


**Course Outcomes (COs):**

At the end of the course, students will be able

1. Characterize aggregates based on mechanical properties.
2. Evaluate bitumen properties for its suitability for various conditions.
3. Characterize and identify the source of binders.
4. Evaluate soil for gradation and strength parameters.
5. Design bituminous mix based on Marshall mix properties.

## DETAILING OF R.C AND STEEL STRUCTURAL ELEMENTS

**Course Code: CVL67**
**Credit: 0:0:2:0** **Contact Hours: 14**

### Course Content:

**List of Experiments:**

**Part - A**

1. Beams: Simply supported, Cantilever and Continuous
2. Slabs: One-way, Two-way and One-way continuous
3. Staircase: Dog legged
4. Cantilever Retaining wall,
5. Counter fort retaining wall
6. Circular Water tanks, Rectangular Water tank
7. Raft Foundation

**Part - B**

8. Beam to beam connections by bolted and welded connection
9. Beam to column connection by bolted connection
10. Beam to column connection by welded connection
11. Built –up Columns with Lacings
12. Built –up Columns with battens
13. Column bases and Gusseted bases with bolted connections
14. Column bases and Gusseted bases with welded connections

**Text Books**


1. N. Krishnaraju "Structural Design & Drawing Reinforced Concrete & Steel", University Press.
2. Krishnamurthy "Structural Design and Drawing (Concrete Structures)", CBS publishers, New Delhi. Tata Mc-Graw publishers.


**References**


1. B.C. Punmia "Reinforced Concrete Structures" Laxmi Publishing Co.
2. S.N.Sinha " Reinforced Concrete Design", McGraw Hill Education.
3. Subramanian .N, "Design of Steel Structures", Oxford University Press, New Delhi.
4. K.S. Duggal, "Design of Steel Structures", Tata Mcgraw Hill, New Delhi.

**Course Outcomes (COs):**

At the end of the course, students will be able

1. Determine the bond length, lap length, splicing and detailing for RC members as per SP 34.
2. Detail the reinforcement of retaining wall and water tank as per codal provisions.
3. Detail the reinforcement of different types of foundation systems.
4. Classify the beam to beam and beam to column connection as pinned, semi rigid and fixed depending on steel connections.
5. Detail the built column with gusset base as per IS:800-2007