

# SAVITRIBAI PHULE PUNE UNIVERSITY



## Board of Studies in Civil Engineering

Structure and Syllabus for B.E. Civil 2015 Course (w. e. f. June, 2018)



**SAVITRIBAI PHULE PUNE UNIVERSITY**  
**Board of Studies in Civil Engineering**  
**Structure for B.E. Civil 2015 Course (w. e. f. June 2018)**

Semester-I											
Subject code	Subject	Teaching Scheme Hrs/Week			In-Semester Assessment	TW	Pract /Or	End- Semester Exam	Total	Credit	
		Lect	Tu	Pr						Th	Lab
401 001	Environmental Engineering II	3	--	2	30	--	50	70	150	3	1
401002	Transportation Engineering	3	--	2	30	50	--	70	150	3	1
401 003	Structural Design and Drawing III	4	--	2	30	--	50	70	150	4	1
401 004	Elective I	3	--	2	30	50	--	70	150	3	1
401 005	Elective II	3	--	--	30	--	--	70	100	3	--
401 006	Project (Phase-I)	--	2	--	--	--	50	--	50	--	2
<b>Total :</b>		16	2	8	150	100	150	350	750	16	6
										<b>22 Credits</b>	

Semester-II											
Subject code	Subject	Teaching Scheme Hrs/Week			In-Semester Assessment	TW	Or	End- Semester Exam	Total	Credit	
		Lect	Tu	Pr						Th	Pr
401 007	Dams and Hydraulic Structures	3	--	2	30	--	50	70	150	3	1
401008	Quantity Surveying, Contracts and tenders	3	--	2	30	--	50	70	150	3	1
401 009	Elective III	3	--	2	30	50	--	70	150	3	1
401 010	Elective IV	3	--	2	30	50	--	70	150	3	1
401 006	Project	--	6	--	--	50	100	--	150	--	6
<b>Total :</b>		12	6	8	120	150	200	280	750	12	10
										<b>22 Credits</b>	

Following will be the list of electives.

### Semester I

<b>Elective-I 401 004</b>	<b>Elective-II 401 005</b>
1. Structural Design of Bridges	1. Matrix Methods of Structural Analysis
2. Systems Approach in Civil Engineering	2. Integrated Water Resources Planning and Management
3. Advanced Concrete Technology	3. TQM & MIS in Civil Engineering
4. Architecture and Town Planning	4. Earthquake Engineering
5. Advanced Engineering Geology with Rock Mechanics	5. Advanced Geotechnical Engineering

### Semester-II

<b>Elective-III 401 009</b>	<b>Elective-IV 401 010</b>
1. Advanced Structural Design	1. Construction Management
2. Statistical Analysis and Computational Methods in Civil Engineering	2. Advanced Transportation Engineering
3. Hydropower Engineering	3. Advanced foundation Engineering.
4. Air Pollution and control	4. Coastal Engineering
5. Finite Element Method in Civil Engineering	<b>5. Open Elective</b>
6. Airport and Bridge Engineering	a) Plumbing Engineering
	b) Green Building Technology
	c) Ferrocement Technology
	d) Sub sea Engineering
	e) Geoinformatics

**Savitribai Phule Pune University, Pune**

**BE Civil 2015 Course**

**Syllabus**

**Semester-I**

**401 001 Environmental Engineering – II**

**Teaching Scheme:**

**Lectures: 3 Hrs/week**

**Practical: 2 Hrs/week**

**Examination Scheme:**

**Paper In-sem : 30 Marks (1Hr.)**

**Paper End-sem : 70 Marks (2.5 Hrs.)**

**Oral : 50 Marks**

**Unit I**

**(6 Hrs.)**

**Sewage quantity:** Collection and conveyance of sewage, sources of sewage, variations in sewage flow, Flow quantity estimation (sewage and storm water quantification), design of storm water system, Design of circular sanitary sewers. Pumping of sewage, necessity, location. Effect of change of life style on sewage quality.

**Characteristics of sewage:** Methods of sampling, Physical, chemical and biological characteristics, Quality requirements for disposal and recycle/reuse of sewage as per CPCB norms.

**Stream sanitation:** Self-purification of natural streams, river classification as per MoEF & CC, Govt. of India; Oxygen Sag Curve, Streeter - Phelps equation and terminology (without derivation and numerical). National river cleaning plan.

**Unit II**

**(6Hrs.)**

**Sewage treatment:** Pollution due to improper disposal of sewage, Introduction to sewage treatment, preliminary, primary, secondary and tertiary treatment, Unit operation and Process flow diagram for sewage treatment, Theory and design of screen chamber, Grit Chamber and Primary sedimentation tank as per the Manual of CPHEEO.

### Unit III

(6 Hrs.)

**Theory & design of secondary treatment units:** Introduction to unit operations and processes for secondary treatment. Principles of biological treatments, role of microorganism in wastewater treatment.

**Activated sludge process:** Theory and design of ASP, sludge volume index, sludge bulking & control, modifications in ASP. Operational problems and maintenance in ASP. Concept of Sequential batch reactor (SBR) .

**Trickling filter:** Biological principle, different T.F media & their characteristics, design of standard rate and high rate filters using NRC formula, single stage & two stage filters, recirculation, ventilation, operational problems, control measures, theory of rotating biological contactors.

### Unit IV

(6 Hrs.)

**Low cost treatment methods for rural areas**

**Oxidation pond:** Bacteria – algae symbiosis, design of oxidation pond as per the manual of CPHEEO, advantages & disadvantages of oxidation ponds.

**Aerated lagoons:** Principle, aeration method, advantages & disadvantages of aerated Lagoons, design of aerated lagoon.

Introduction and theory of Phytoremediation technology for wastewater treatment. Introduction and theory of root zone cleaning system.

### Unit V

(6 Hrs.)

**Onsite Sanitation Treatment systems:** Septic tank, up-flow anaerobic filter. and Package Sewage Treatment Plant- Working principle, advantages and disadvantages. Introduction to MBR, MBBR and FMBR.

**Anaerobic digester:** Principle of anaerobic digestion, stages of digestion, bio – gas production its characteristics & application, factors governing anaerobic digestion,. Dewatering of sludge by gravity thickener, sludge drying bed, decanters. Methods of sludge treatment and disposal, advantages & disadvantages. Up-flow Anaerobic Sludge Blanket (UASB) Reactor– Principle, advantages & disadvantages.

## Unit VI

(6 Hrs.)

**Industrial waste water treatment:** Equalization and neutralization. Application of preliminary, primary and secondary treatment for industrial wastewater as per the CPCB norms.

Sources of waste water generation from manufacturing process, characteristics of effluent, different methods of treatment & disposal of effluent for the following industries: Sugar, dairy and distillery. Discharge standards as per CPCB norms.

**Recycle & reuse of treated wastewater:** Gardening, sewage farming, W.C. Flushing, reuse in industry.

### Term Work:

#### A. Compulsory Assignment:

1. Brief report on Sewer materials, choice of materials, testing of sewer pipes, sewer appurtenances.
2. Design of septic tank.

#### B. Experiments:

The term work shall consist of a journal giving details of at least 8 out of 12 of the following experiments conducted in Environmental Engineering laboratory, of which, **Sr.No.12 is compulsory.**

#### Determination of

1. Solids -Total solids, suspended solids, volatile solids, settle able solids & non settle able solids.
2. Sludge Volume Index.
3. Dissolved oxygen.
4. Bio-Chemical Oxygen Demand.
5. Chemical Oxygen Demand.
6. Electrical Conductivity.
7. Determination of Phosphates by spectrophotometer.
8. Determination of Nitrates by spectrophotometer.
9. Determination of heavy metals like Cr<sup>6+</sup> or Zn or Ni or Cd.
10. Determination of total nitrogen by Kjeldal method.
11. Visit to domestic / Industrial wastewater treatment plant & its detailed reports.

**12. Computer aided design of Sewage Treatment Plant (STP) OR Effluent Treatment Plant (ETP) of Sugar or Dairy Industry using suitable software (C programming or any other suitable software).**

**Note: - Term Work should include a detailed analysis of practical interpretation, significance and application of test results.**

**Text Books:**

1. Environmental studies by Rajgopalan- Oxford University Press.
2. Waste Water Treatment & Disposal – Metcalf & Eddy - TMH publication.
3. Environmental Engg. - Peavy, Rowe - McGraw Hill Publication.
4. Waste Water Treatment – Rao & Dutta.

**Reference Books:**

5. Waste Water Engg. – B.C. Punmia & Ashok Jain - Arihant Publications.
6. Water Supply & Waste Water Engg.- B.S.N. Raju – TMH publication.
7. Sewage Disposal & Air Pollution Engg. – S. K. Garg – Khanna Publication.
8. Environmental Engg. – Davis - McGraw Hill Publication.
9. Manual on sewerage and sewage treatment – Public Health Dept., Govt. of India.
10. Standard Methods by APHA.

**I.S. Codes:**

I.S. 3025 (all parts).

**e – Resources:**

- i) <http://nptel.iitm.ac.in/courses-contents/IIT Kanpur and IIT Madras>.
- ii) <http://cpcb.nic.in>
- iii) <http://moef.nic.in>

# 401 002 Transportation Engineering

## Teaching scheme

Lectures: 3 Hrs/week

Practical: 2 Hrs/week

## Examination Scheme

In-Sem Exam: 30 Marks 1 Hr.

End-Sem Exam: 70 Marks 2.5 Hrs.

Term work: 50 Marks

### Unit I

(6 Hrs.)

#### Highway Development & Planning:

History, Development Plans, Classification of roads, Road Patterns, road development in India - Vision 2021 & Rural Road Development Vision 2025, Current road projects in India; highway alignment and highway project report preparation (Planning surveys & Master Plans based on saturation system).

### Unit II:

(6 Hrs.)

#### Geometric design of highways:

Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems, Highway drainage, Importance of highway drainage, subsurface and surface drainage systems.

### Unit III

(6 Hrs.)

#### Traffic engineering & control:

Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control devices (signs, signals, islands, road markings); Accident studies, types of road intersections; parking studies; highway lighting.

### Unit IV

(6 Hrs.)

#### Pavement materials:

Materials used in Highway Construction and related tests - Soil subgrade and CBR Test, Stone aggregates, bituminous binders, bituminous paving mixes, viscosity based gradation of bitumen, Modified Bitumen (Cutbacks, Emulsions, Crumbed Rubber Modified Bitumen – CRMB, Polymer Modified Bitumen-PMB, Foamed Bitumen), Marshall Stability Mix Design and Test (All 5 test parameters).



## **Unit V**

**(6 Hrs.)**

### **Pavement Design:**

Introduction; flexible pavements – Computation of design traffic (Vehicle Damage Factor VDF, Lane distribution factor LDF, Traffic growth rate); stresses in flexible pavements; design guidelines for flexible pavements as per IRC 37-2012 (steps only); rigid pavements- components and functions; factors affecting design; stresses in rigid pavements (ESWL); design guidelines for concrete pavements as per IRC 58-2015 (steps only); joints in CC pavements, problems.

## **Unit VI**

**(6 Hrs.)**

### **A. Pavement Construction:**

Construction process of GSB, WBM, WMM; Cemented base, Introduction to bituminous works such as prime coat, tack coat, seal coat, Built-up Spray Grout (BSG), Asphaltic Concrete (AC) or Bituminous Concrete (BC), Bituminous Macadam (BM), Dense Bituminous Macadam (DBM) and premix carpet, Dry lean Concrete (DLC), Pavement Quality Concrete (PQC).

### **B. Modern Trends in Highway Materials, Construction & Maintenance:**

Mastic Asphalt, Cold Mix Asphalt Technology, Warm Mix Asphalt Technology, Recycled/Reclaimed Asphalt Pavement (RAP) (Manual Series - 2), Concept of Super pave Mix Design (Super pave Series 2), Non-Destructive Evaluation of Pavements (Falling Weight Deflectometer FWD).

### **Term work:**

**Term work shall consist of the following:**

#### **A. Practicals:**

##### **I. Tests on Aggregate (Any Five) :**

1. Aggregate Impact Value Test
2. Aggregate Crushing Strength Test
3. Los Angeles Abrasion Test
4. Shape Test (Flakiness Index and Elongation Index)
5. Specific Gravity and Water Absorption Test by basket method
6. Stripping Value Test
7. Soundness Test

## **II. Tests on Bitumen (Any Five):**

1. Penetration Test
2. Ductility Test
3. Viscosity Test (Tar Viscometer)
4. Softening Point Test
5. Flash Point & Fire Point Test
6. Specific Gravity Test
7. Bitumen Extraction Test

## **III. Tests on Aggregate Bitumen Combined:**

1. Marshall Stability Test

## **IV. Tests on Soil Subgrade:**

1. California Bearing Ratio Test (CBR Test)

## **B. Technical visits to:**

- 1) Road Construction and/or RAP Site
- 2) Hot mix Plant with detailed report

## **Text Books:**

1. Highway engineering – S.K. Khanna, C.E.G. Justo & A. Veeraragavan, Nem Chand and Brothers, Roorkee
2. Principles of Highway Engineering and Traffic Analysis (4<sup>th</sup> edition) F. L. Mannering, Scott S. Washburn, Wiley India
3. Principles and practices of Highway engineering –Dr. L.R. Kadiyali, Khanna Publishers Delhi.

## **Reference Books:**

1. A Course in Highway Engineering – S.P. Bindra, Dhanpat Rai and Sons, Delhi.
2. Principles of Transportation Engineering – G.V. Rao Tata MacGraw Hill Publication
3. Highway Engineering – Rangawala, Charotar publishing House, Anand 388001 (Gujrat)
4. Principles of Transportation Engineering – Partha Chakraborty, Animesh Das, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Highway and Bridge Engineering – B.L. Gupta, Amit Gupta Standard publishers Distributors, Delhi.

**Other References:**

1. National Cooperative Highway Research Program (NCHRP)
2. Federal Highway Authority (FHWA)

**Codes:**

1. I.S. 1201 TO 1220-1978, IS 73, IS 2386 PART I to V
2. I.R.C. 58- 2015, IRC 37-2012
3. Specifications for Road and Bridge works (MORTH) 5<sup>th</sup> Revision, New Delhi.

**e – Resources:**

1. [www.nptel.iitm.ac.in/courses/iitkanpur](http://www.nptel.iitm.ac.in/courses/iitkanpur)
2. [www.cdeep.iitb.ac.in/nptel](http://www.cdeep.iitb.ac.in/nptel)
3. [www.fhwa.dot](http://www.fhwa.dot)

## 401 003 Structural Design and Drawing III

### Teaching Scheme:

Lectures: 4 Hrs / week

Practical: 2 Hrs/week

### Examination Scheme:

In Sem: 30 and End Sem : 70 Marks

Oral: 50 Marks

Duration: In-Sem: 1.5 Hrs.

End-Sem: 3 Hrs.

### Unit 1

(8 Hrs.)

#### Prestressed concrete – Analysis:

Introduction, Basic concepts, materials, various Pre-tensioning and Post-tensioning systems, concept of losses, Stress calculations, and concept of cable profile.

### Unit 2

(8 Hrs.)

#### Prestressed concrete – Design:

Design of post tensioned prestressed concrete simply supported rectangular and flanged sections for flexure and shear including end block.

Design of one way and two way post tensioned slabs (Single panel only).

### Unit 3

(8 Hrs.)

#### Design of Flat slab:

Introduction to flat slab, Design of prestressed two way flat slab by direct design method.

### Unit 4

(8 Hrs.)

#### Earth retaining structures:

Introduction, Functions and types of retaining walls, Analysis and design of RCC cantilever type of retaining wall for various types of backfill conditions.

### Unit 5

(8 Hrs.)

#### Liquid retaining structures:

Introduction, types, function, codal provisions, methods of analysis, Design of circular, square, and rectangular water tanks resting on ground by working stress method, Introduction to limit state design of water tanks.

## Unit 6

(8 Hrs.)

### Introduction to vibration and earthquake analysis:

Introduction to single and multi-degree of freedom systems: free, forced, un-damped and damped vibration, Estimation of earthquake forces by seismic coefficient method, Estimation of combined effect of lateral forces and vertical loading on G+2 storied frames.

**Note: Design based on above unit shall conform to latest versions of IS 456, IS 875, IS 1343, IS 3370, IS 1893, IS 13920.**

### Term Work:

**Term work shall be based on the above syllabus. It consists of**

- 1) Assignment on calculation of losses in prestress.
- 2) Assignment on stress calculation in prestressed structures.
- 3) Design and detailing of design of prestressed girder.
- 4) Design and detailing of prestressed flat slab by direct design method.
- 5) Design and detailing of retaining wall for various loading conditions.
- 6) Design and detailing of ground resting water tank.
- 7) Report on analysis and design of any one of the structures listed in the syllabus using software or computer program.
- 8) Two site visit reports, one each on RCC and Prestressed concrete structure.

### Note:

- (a) There should be separate design problem statement for a group of students not exceeding *four* in numbers.
- (b) Minimum *four* full imperial sheets based on two projects on design of RCC and two projects on design of prestressed concrete structural elements.

### Text Books:

1. Limit state theory and design of reinforced - Dr. V. L. Shah and Dr S. R. Karve - Structures Publications, Pune.
2. Fundamentals of Reinforced Concrete- N.C. Sinha, S.K. Roy – S. Chand & Co. Ltd
3. Advanced design of structures- Krishnaraju - Mc Graw Hill.
4. Design of Prestressed concrete structures- T. Y. Lin.
5. Prestressed Concrete- N. Krishna Raju – Tata Mc Graw Hill Publication Co.
6. Earthquake resistant design of structures- Agarwal, Shrikhande, PHI learning.

**Reference Books:**

7. Comprehensive RCC Design - Punmia, Jain & Jain - Laxmi Publications.
8. Design of design of reinforced Concrete structures- M. L. Gambhir –PHI.
9. Reinforced Concrete, Vol I- Dr.H J. Shah Charotar Publishing House
10. Prestressed Concrete – A Fundamental Approach- Edward Nawy – PHI..
11. Reinforced concrete design- Pillai and Menon TMH.
12. Elementary Structural Dynamics-Selvam, Dhanpatrai Publications.

**I.S. Codes**

1. IS: 456: Indian Standard code of practice for plain and reinforced concrete, BIS, New Delhi.
2. IS: 1343: Indian Standard code of practice for Prestressed concrete, BIS, New Delhi.
3. IS: 1893: Indian Standard Code of practice for criteria for Earthquake resistant design of structures, BIS, New Delhi.
4. IS: 3370-Indian Standard code of practice for concrete structures for storage of liquids, BIS, New Delhi.

## 401 004 Elective I: (1) Structural Design of Bridges

### Teaching Scheme:

Lecture: 3 Hrs/week.

Practical:- 2 Hrs/week

### Examination Scheme:

In-sem. Exam.: 30 Marks (1 Hr.)

End Sem. Exam.: 70 Marks (2.5 Hrs.)

Term work: 50 Marks.

### Unit 1

(6 Hrs.)

**Introduction to RC highway bridges and steel railway bridges:** Types of bridges, classification, IRC codal provisions for RC highway bridges, IRS codal provisions for railway steel bridges, loading standards.

### Unit 2

(6 Hrs.)

**RC highway bridges: Slab culvert and T-beam deck slab bridges** – Design of slab culvert, Deck slab: Structural configuration, Piégaud's method, analysis and design of deck slab.

### Unit 3

(6 Hrs.)

**RC highway bridges: T-beam deck slab bridges – Post tensioned girders:** Load distribution on longitudinal and cross girders, methods of analysis, analysis and design of longitudinal and cross girders.

### Unit 4

(6 Hrs.)

**Railway steel bridges – Truss bridges:** Structural configurations, loads and load combinations, analysis and design of truss elements, longitudinal and cross-girders, bracing systems.

### Unit 5

(6 Hrs.)

**Bearings:** Function of bearings, types of bearings, design of steel bearings and elastomeric bearings.

### Unit 6

(6 Hrs.)

**Sub-structure:** Function, loads, analysis and design of RC abutments and piers, design of well foundation.

**Note:** The designs should conform to the latest codal provisions.

**Term Work:**

- a) One project on RC highway bridges which shall include - the design of deck slab, longitudinal girder, cross-girder, bearings and abutment and pier.

The detailing shall be shown in at least three full imperial sheets.

- b) One project on railway steel bridges which shall include – the design of truss elements, longitudinal girder, cross-girder, and bearings.

The detailing shall be shown in at least two full imperial sheets.

- c) The term work can be prepared in a group of not more than four students in a group.

- d) Report of at least two site visits covering the contents of the syllabus.

- e) The projects can be done using any drafting software.

**Reference Books:**

1. Design of Bridges, N. Krishna Raju, Oxford and IBH Publishing Company Pvt. Ltd.
2. Design of Bridge Structures, M.A. Jayaram Prentice-Hall Of India Pvt. Limited. Prestressed Concrete, N. Krishna Raju, Tata-McGraw Hill.
3. Design of Steel Structures, Ramachandra, Standard Publications New-Delhi.



## 401 004 Elective I (2) - Systems Approach in Civil Engineering

### Teaching scheme:

Lectures: 3 Hrs/week

Practical: 2 Hrs/week

### Examination scheme:

In semester exam: 30 marks---1 Hr.

End semester exam: 70 marks—2.5 Hrs.

Term Work: 50 marks.

### Unit 1: Introduction of systems approach

(6 Hrs)

- (A) Introduction to System approach, Operations Research and Optimization Techniques, Applications of systems approach in Civil Engineering.
- (B) Introduction to Linear and Non linear programming methods (with reference to objective function, constraints), Graphical solutions to LP problems.
- (C) Local & Global optima, unimodal function, convex and concave function.

### Unit 2: Stochastic Programming

(6 Hrs)

- (A) Sequencing— n jobs through 2, 3 and M machines.
- (B) Queuing Theory : elements of Queuing system and it's operating characteristics, waiting time and ideal time costs, Kendall's notation, classification of Queuing models, single channel Queuing theory : Model I (Single channel Poisson Arrival with exponential services times, Infinite population (M/M/1) : (FCFS/ /).
- (C) Simulation : Monte Carlo Simulation.

### Unit3: Linear programming (A)

(6 Hrs)

- (A) The Transportation Model and its variants.
- (B) Assignment Model, and its variants.

### Unit 4: Linear programming (B)

(6 Hrs)

- (A) Formulation of Linear optimization models for Civil engineering applications. The simplex method.
- (B) Method of Big M, Two phase method, duality.

### Unit 5: Nonlinear programming

(6 Hrs)

- (A) Single variable unconstrained optimization: Sequential Search Techniques-Dichotomous, Fibonacci, Golden section.

- (B) Multivariable optimization without constraints-The gradient vector and Hessian Matrix, Gradient techniques, steepest ascent/decent technique, Newton's Method.
- (C) Multivariable optimization with equality constraints - Lagrange Multiplier Technique.

**Unit 6: Dynamic programming, Games Theory & Replacement Model (6 Hrs)**

- (A) Multi stage decision processes, Principle of optimality, recursive equation, Applications of D. P.
- (B) Games Theory – 2 persons games theory, various definitions, application of games theory to construction Management.
- (C) Replacement of items whose maintenance and repair cost increase with time, ignoring time value of money.

**Term Work :**

1. One exercise/assignment on each unit. Out of these any one exercise/assignment to be solved using Computer.
2. One exercise on formulation of a problem applicable to any field of Civil Engineering, requiring use of LP/ NLP/ DP. Formulation of objective function and constraints (No solution).

**Text Books :**

1. Operations Research by Premkumar Gupta and D.S.Hira, S. Chand Publications (2014).
2. Engineering Optimization: Methods and Application-- A. Ravindran, K. M. Ragsdell—Wiley India.
3. Engineering Optimization by S. S. Rao.
4. Operations Research by Hamdy A. Taha.
5. Quantitative Techniques in Management by N.D. Vohra ( Mc Graw Hill ) .
6. Operations Research by Pannerselvam, PHI publications.

**Reference Books :**

1. Topics in Management Science by Robert E. Markland( Wiley Publication).
2. An Approach to Teaching Civil Engineering System by Paul J. Ossenbruggen.
3. A System Approach to Civil Engineering Planning & Design by Thomas K. Jewell (Harper Row Publishers).

### **e - Resources**

1. Mathematical Model for Optimization (MMO Software).
2. [nptel.iitm.ac.in/courses/webcourse-contents/IISc-Bang/OPTIMISATION METHODS/New-index1.html](http://nptel.iitm.ac.in/courses/webcourse-contents/IISc-Bang/OPTIMISATION METHODS/New-index1.html).

## **401004 Elective I (3) - Advanced Concrete Technology**

### **Teaching scheme**

**Lectures: 3 Hrs/week**

**Practical: 2 Hrs/week**

### **Examination scheme**

**In semester exam: 30 Marks-1 Hr.**

**End semester exam: 70 Marks—2.5 Hrs.**

**Term Work: 50 Marks**

### **Unit I**

**(6 Hrs.)**

Cement and its types: general, hydration of cement, alkali aggregate reaction. Grading curves of aggregates, Manufactured sand as fine aggregate, copper slag as fine aggregate.

Concrete: properties of concrete, w/b ratio, gel space ratio, Problems on maturity concept, aggregate cement bond strength, Green concrete, Guidelines for Quality control & Quality assurance of concrete, Effect of admixtures.

### **Unit II**

**(6 Hrs.)**

Structural Light weight concrete, ultra light weight concrete, vacuum concrete, mass concrete, waste material based concrete, sulphur concrete and sulphur infiltrated concrete, Jet cement concrete (ultra rapid hardening), gap graded concrete, high strength concrete, high performance concrete, Self curing concrete, Pervious concrete, Geo polymer concrete .

### **Unit III**

**(6 Hrs.)**

Design of high strength concrete mixes, design of light weight aggregate concrete mixes, design of fly ash cement concrete mixes, design of high density concrete mixes, Design of pump able concrete mixes, Design of self-compacting concrete.

Advanced non-destructive testing methods: ground penetration radar, probe penetration, break off maturity method, stress wave propagation method, electrical/magnetic methods, nuclear methods and infrared thermographs.

### **Unit IV**

**(6 Hrs.)**

Historical development of fibre reinforced concrete, properties of metallic fibre, polymeric fibres, carbon fibres, glass fibres, Basalt fibres and naturally occurring fibres. Interaction between fibres and matrix (uncracked and cracked matrix), basic concepts and mechanical properties: tension and bending.

## Unit V

(6 Hrs.)

Properties of hardened frc, behavior under compression, tension and flexure of steel fibres and polymeric fibres, GFRC, SFRC, SIFCON, SIMCON -development, constituent materials, casting, quality control tests and physical properties.

## Unit VI

(6 Hrs.)

Ferrocement: Properties & specifications of ferrocement materials ,analysis and design of prefabricated concrete structural elements,manufacturing process of industrial concrete elements, precast construction, erection and assembly techniques.

### Termwork / Labwork :

The Termwork / Labwork will be based on completion of assignments / practicals / reports of site visits, confined to the course in that semester.

1. Write a review on any recent research article from standard peer-reviewed journal.
2. Report on at least one patent (national/international)– on any topic related to concrete technology.
3. Concrete mix design and production in lab of any one – Self compacting concrete, Fiber reinforced concrete, light-weight concrete, high strength or ultra-high strength concrete . Comparison with traditional concrete mix is to be clearly stated in the report.
4. Cost analysis (material, labour, equipment, others) of any type of concrete for lab, in-situ and RMC production.
4. Perform any two Fresh (workability tests – Slump Flow Test, T-50, J-Ring, Visual Stability Index, Column Segregation, L-Box, U-box) and Hardened (Compressive, tensile, flexural) properties tests on any high performance concrete.
5. Any one experiment on any one of the topics – NDTs; Microscopic examination of cement/concrete; Performance study of any one admixture (Mineral/Chemical) in concrete.
6. Visit reports on minimum two site visits - exploring the field and practical aspects of concrete technology.

### Note:

Term Work should include a detailed analysis of practical interpretation, significance and application of test results including above contents and site visit report in form of journal.

**Text books:**

1. Concrete Technology --M.S. Shetty, S. Chand Publications.
2. Concrete Technology -- A R Santhakumar, Oxford University Press.
3. Concrete technology -- M. L. Gambhir, Tata Mcgraw Hill Publications.
4. Fiber Reinforced Cement Composite- P.N.Balguru & P.N.Shah.
5. Concrete: Microstructure, Properties and Materials-- P. Kumar Mehta and P. S. M. Monteiro--  
Tata Mc-Graw Hill Education Pvt. Ltd.

**Reference Books:**

1. Handbook on Advanced concrete Technology Edited by N V Nayak, A .K.Jain, Narosa Publishing House .
2. Design of concrete mixes by Raju N Krishna, CBS Publisher.
3. Properties of concrete by A. M. Neville, Longman Publishers.
4. Concrete Technology by R.S. Varshney, Oxford and IBH.
5. Concrete technology by A M. Neville, J.J. Brooks, Pearson.
6. Ferrocement Construction Mannual-Dr. D.B.Divekar-1030, Shivaji Nagar, Model Colony, Pune.
7. Concrete Mix Design-A.P.Remideos--Himalaya Publishing House (ISBN-978-81-8318-996-5
8. Concrete, by P. Kumar Metha, Gujrat Ambuja.
9. Learning from failures ---- R.N.Raikar.
10. Structural Diagnosis ---- R. N. Raikar.
11. Concrete Mix Design---Prof. Gajanan Sabnis.

**General Reading suggested:**

- 1) Codes : i) IS 456 ii) IS 383 iii) IS 10262-2009 iv) IS 9103.
- 2) Ambuja cement booklets on concrete Vol .1 to 158.
- 3) ACC booklets on concrete.

## **401 004 Elective I (4)- Architecture and Town Planning**

### **Teaching scheme:**

**Lectures: 3 Hours/week**

**Practical: 2 Hrs/week**

### **Examination scheme:**

**In semester exam: 30 marks-1 Hr.**

**End semester exam: 70 marks-2.5 Hrs.**

**Term Work: 50 marks**

### **Unit I**

**(6 Hrs.)**

- Principles and elements of Architectural Composition.
- Qualities of Architecture: user friendly, contextual, ecofriendly, utility of spaces, future growth etc.
- Role of “Urban Planner and Architect” in planning and designing in relation with spatial organization, utility, demand of the area and supply.

### **Unit II:**

**(6 Hrs.)**

- Landscaping: importance , objectives, principles, elements, material (soft and hard).
- Urban renewal for quality of life and livability.
- Importance of sustainable architecture with case study.

### **Unit III:**

**(6 Hrs.)**

- Goals and Objectives of planning; components of planning; benefits of planning.
- Levels of planning: Regional plan, Development Plan, Town Planning Scheme.
- Neighborhood plan; Types of Development plans: Master Plan, City Development Plan, Structure Plan.

### **Unit IV:**

**(6 Hrs.)**

- Various types of civic surveys for DP: demographic, housing, land use, Water Supply & sanitation, etc.
- Planning agencies for various levels of planning. Their organization and purpose (CIDCO-MHADA-MIDC, MMRDA/ PMRDA etc).
- Traffic transportation systems: urban road, hierarchy, traffic management, Intelligent Transport Systems.

**Unit V:****(6 Hrs.)**

- Legislative mechanism for preparation of DP: MRTTP Act 1966.
- UDPFI guidelines (for land use, infrastructure etc.), SEZ, CRZ, Smart City Guidelines.

**Unit VI :****(6 Hrs.)**

- Special townships, Land Acquisition Rehabilitation and Resettlement Act 2013.
- Application of GIS, GPS, remote sensing in planning.

**Term Work: - 50 Marks****Sr. no. 1 and 2 are compulsory and any four from remaining.**

1. Study and analysis of Development Plan with respect to land use, services, infrastructure, street furniture, housing etc. (group work).
2. Neighborhood- planning (group work).
3. Report on contribution of Engineers, Planners and Architects in post-independence India (individual work).
4. Report on any existing new towns and planned towns like new Mumbai, Gandhinagar, PCNTDA etc.(infrastructure, disaster management etc), (individual work).
5. Study of salient features of urban renewal schemes (group work).
6. Study of any existing town planning scheme (group work).
7. Smart City approaches (individual work).
8. Study of Special Townships: (site visit) (group work).
9. Study of urban housing and housing change (group work).

**Text Books:**

1. Town Planning By G K Hiraskar --Town Planning by S Rangwala.
2. Building Drawing and Built Environment- 5<sup>th</sup> Edition – Shah, Kale, Patki--Planning Legislation by Koperdekar and Diwan.
3. G. K. Bandopadhyaya, “Text Book of Town Planning”.
4. Climate Responsive Architecture – Arvind Krishnan.
5. Introduction to Landscape Architecture by Michael Laurie.

**Reference Books:**

- MRTTP Act 1966.
- Manual Of Tropical Housing And Building By Koenigsbeger.



- Sustainable Building Design Manual.
- UDPFI Guidelines.
- “The Urban Pattern: City planning and design” by Gallion and Eisner.
- Design of cities by Edmond bacon.
- LARR Act 2013.
- MoUD By GoI.
- Web sites of NRSA, CIDCO, MHADA, MIDC, MMRDA, PMRDA.

## **401004 Elective-I (5) Advanced Engineering Geology with Rock Mechanics**

### **Teaching Scheme:**

**Lecture: 3 Hrs/week**

**Practical: 2 Hrs/week**

### **Exam. Scheme:**

**In Sem: 30 Marks (1 Hr.)**

**End Sem: 70 Marks (2.5 Hrs.)**

**Termwork: 50 Marks**

### **Unit I:**

**(6 Hrs.)**

#### **Indian Geology, Seismic Zones and Geological Studies in Engineering Projects.**

Geological Map of India with special reference to Maharashtra. Distribution and Geological characters of Major rock formations of India. Engineering characters of major rock formations of India. Engineering characters of major rock formations of India. Engineering characters of major rock formations of India. Engineering characters of major rock formations of India.

The study of Plate Tectonics and highlights of Seismic Zones of India. Importance of geological studies in engineering investigations.

### **Unit II**

**(6 Hrs.)**

#### **Geohydrological characters of rock formations and Geological process of Soil formations**

##### ***Geohydrological characters of major rock formations of India:***

Geohydrological characters and factors controlling various characters of rocks. Introduction to morphometric analysis. Various water conservation techniques, effect of over exploitation of tube wells, bore wells and dug wells. Artificial recharge, rainwater harvesting, watershed development and necessity of geological studies. Relevant case studies highlighting success and failure of these techniques.

##### ***Geological Process of Soil formations:***

Effect of climate on formation of soil. Soil profile of different states in India.

Rock weathering conditions favorable for decomposition, disintegration, residual and transported soils.

### **UNIT III**

**(5 Hrs.)**

#### **Resource Engineering, Role of Geology in planning and development.**

##### ***Resource Engineering:***

Utility of various rock formations as construction material. Illustrative case studies.

Geological Hazards and mitigation.

***Role of Geology in planning and development:***

Influence of geological factors upon urban development & planning. Reclamation of abandoned grounds and mining regions, illustrative examples.

**UNIT IV:**

**(6 Hrs.)**

**Rock Mechanics and Geophysical techniques.**

***Rock Mechanics:***

General principles of rock mechanics. Dependence of physical and mechanical properties of rocks on geological characters.

Analyzing and evaluating of core recovery, R.Q.D. and Joint Frequency Index.

Various Methods of Geomechanical classifications of rocks such as Terzaghi, U.S.B.M, R.M.R., R.S.R., Q- system, Deer and Miller, Bieniawski's geomechanical classification etc.

***Geophysical techniques :***

Electrical Resistivity method and Seismic method of exploration. Evaluation and analyzing the data produced through electrical resistivity for the determination of thickness of overburden, locating ground water potential zones which leads for strengthening the major civil projects.

**UNIT V**

**(7 Hrs.)**

**Subsurface Geological Explorations for various projects; Foundation Treatments, Tail Channel Erosion.**

***Subsurface Explorations for Dams, Reservoir, Percolation Tanks:***

The strength and water tightness of rocks found at the dam, reservoir and percolation tank site.

Case studies illustrating the success and failure of major projects owing to negligence of geological studies. Earthquakes occurring in the areas of some dams and RIS theories.

***Geological Foundation Treatments for various Civil Engineering Projects:***

Foundation investigation during construction of projects for assessing various geological defects in rocks and suggesting appropriate remedial measures by various methods of grouting.

***Erosion of Tail Channels:***

Geological reasons for selection of site for spillway, causes of erosion of tail channel. Relevant Case studies.

## Unit VI:

(6 Hrs.)

### Geological exploration for Tunnels and Bridges

#### *Geological exploration for Tunnels:*

Variations in methodology of investigation for different types of tunnels for different purposes, location, spacing, angles & depths of drill holes suitable for different types of tunnels.

Difficulties introduced in various geological formation and their unfavorable field characters.

Standup time of rock masses and limitations of it.

Dependence of protective measures such as guniting, rock bolting, shotcreting, steel fiber shotcreting, permanent steel supports, lagging concreting & grouting above permanent steel supports on geological conditions. Illustrative case studies.

*Bridges* Investigation for bridge foundation, difference in objectives of investigation of bridge foundation. Bridge foundation based on nature & structure of rock. Foundation settlements. Case studies.

#### **Practical Work / Term Work**

- i. Study of Geological map and seismic zone map of India **(2 Practicals)**
- ii. Study of Morphometric Analysis of river, (topsheet will be made available by the college) **(1 Practical)**
- iii. Study of Soil Profile, weathering index and clay geology. **(1 Practical)**
- iv. Use of electrical resistivity method for determining depth of bedrock. **(1 Practical)**
- v. Engineering Classification of rocks and Computation of RQD & Joint Frequency Index **(1 Practical)**
- vi. Interpretation of drill hole data. Logging of drill cover, preparation of Litho logs & interpretation of drill data. Preparing geological cross sections from drill hole data & using them for designing of civil engineering structures representing following case studies.
  1. Dipping sedimentary formation.
  2. Faulted region.
  3. Folded region.
  4. Locating spillway.
  5. Tunnels in Tectonic areas.
  6. Tunnels and open cuts in non-tectonic areas. **(6 Practicals)**
- vii. A compulsory guided tour to study geological aspects of an engineering projects & writing a report based on studies carried out during visits to civil engineering projects.

**Note:**

**Field visits will be made to different places around study area and one study tour to important geological places.**

The practical journal will be examined as term work.

**REFERENCE BOOKS AND TEXT BOOKS:**

1. Jaeger J. C., Cook N. & Zimmerman R. – Fundamentals of Rock Mechanics, Blackwell Scientific Publications.
2. Goodman R. E. – Introduction to Rock Mechanics, John Wiley & Sons.
3. Bieniawski Z. T. - Engineering Classification of jointed Rock Masses.
4. M. B. Dobbrin - Introduction to Geophysical Prospecting, McGraw Hill Inc., USA.
5. B. P. Verma - Introduction to Rock Mechanics, Khanna Pub New Delhi.
6. Keller E A - Environmental Geology, Prentice – Hall Publication.
7. Subinoy Gangopadhyay - Engineering Geology, Oxford University Press.
8. Vasudev Kanithi – Engineering Geology, Universities Press.
9. Dr. J. B. Auden Commemorative Volume – Indian Soc. Of Engineering Geology, Culcutta.
10. Seminar on Engineering and Geological Problems in Tunneling (Part 1 & 2) – Indian Society of Engineering Geology, New Delhi.

**Handbooks:**

- a. Gupte R. B. (1980) – P. W. D. Handbook Chapter –6, Part-II ‘Engineering Geology Government of Maharashtra.
- b. Tunneling India '94, “Central Board of Irrigation and Power”, New Delhi.
- c. Manual on Rock Mechanics, Central Board of Irrigation and Power, New Delhi, 1988.
- d. Handbook of Geology in Civil engineering, Robert Fergusson, Legget, Mc- Graw hill.

**I. S. Codes**

- a. IRC code of practice for Road Tunnels. IRC-78-2000; IS-12070; IS-1336 Part I and II.
- b. I. S. 4453-1967 Code of practice for Exploration, pits, trenches, drifts & shaft.
- c. I. S. 6926-1973 Code of practice for diamond drilling for site investigation river valley project.
- d. I. S. 4078-1967 Code of practice for Logging and Storage of Drilling Core.
- e. I. S. 5313-1969 Guide for core drilling observation.

**e- Resources:**

1. [www.ebd.co.in/undergraduate/eng](http://www.ebd.co.in/undergraduate/eng)
2. [www.library.iisc.ernet.in](http://www.library.iisc.ernet.in)
3. [www.iitb.ac.in](http://www.iitb.ac.in)
4. [www.nptel.iitm.ac.in](http://www.nptel.iitm.ac.in)
5. Free online course-swayam-<https://swayam.gov.in>
6. Open source course management – <https://moodle.org>

## **401 005 Elective-II (1) Matrix Methods of Structural Analysis**

### **Teaching scheme:**

**Lectures: 3 Hrs/week**

### **Examination scheme:**

**In semester exam: 30 marks (1 Hr.)**

**End semester exam: 70 marks (2.5 Hrs.)**

### **Unit I: Computational Techniques**

**(6 Hrs)**

Review of matrix algebra, computer oriented numerical methods-Gauss elimination, Gauss Jordan and Gauss Seidel. Computer algorithm and flowcharts of above methods.

### **Unit II: Flexibility matrix method for beams and frame**

**(6 Hrs)**

Degree of static indeterminacy, flexibility, selection of redundant, flexibility matrix, analysis of indeterminate continuous beams and simple portal frames involving not more than three unknowns.

### **Unit III: Stiffness matrix method for bars and trusses**

**(6 Hrs)**

- a) Degree of kinematic indeterminacy (degrees of freedom), local and global coordinate systems, stiffness matrices of a axially loaded bar members, global stiffness matrix, analysis of determinate/indeterminate bars involving not more than three unknowns using member approach.
- b) Stiffness matrices of a truss member with four DOF, transformation matrix, global stiffness matrix, analysis of determinate/indeterminate trusses involving not more than three unknowns using member approach.

### **Unit IV: Stiffness matrix method for beams**

**(6 Hrs)**

- a) Structure approach: Degree of kinematic indeterminacy, problems involving not more than three unknowns.
- b) Member approach: Derivation of stiffness matrix for beam member, Global stiffness matrix, problems involving not more than three unknowns.

### **Unit V: Stiffness matrix method for frames**

**(6 Hrs)**

- a) Structure approach: Degree of kinematic indeterminacy, problems involving not more than three unknowns.
- b) Member approach: Derivation of stiffness matrix for plane and space frame member, transformation matrix, global stiffness matrix, problems involving not more than three unknowns.

## **Unit VI: Stiffness matrix method for grid structures**

**(6 Hrs)**

- a) Structure approach: Degree of kinematic indeterminacy, problems involving not more than three unknowns.
- b) Member approach: Derivation of stiffness matrix for grid member, transformation matrix, global stiffness matrix, problems involving not more than three unknowns.

### **Reference Books:**

- [1] Matrix Methods of Structural Analysis- Wang, C. K., International Textbook Co., 1970.
- [2] Matrix Analysis of Framed Structures – Gere & Weaver- CBS Publications, Delhi.
- [3] Matrix & Finite Element analysis of structures – A.H. Shaikh and Madhujit Mukhopadhyay.
- [4] Numerical Methods for Engineering – S.C. Chapra & R.P. Canale Tata McGraw Hill Publication.
- [5] Structural Analysis – A Matrix Approach – Pandit & Gupta - Tata McGraw Hill Publication.
- [6] Matrix Methods of Structural Analysis – Meghre & Deshmukh- Charotar Publishing House, Anand.



**Teaching Scheme: Lectures: 3 Hrs / week**

**Examination Scheme:**

**Paper In-sem. 30 Marks (1 hr),**

**Paper End-sem : 70 Marks (2.5 hr)**

**Unit1:**

**(6 Hrs)**

**a) Introduction :** World water resources, water resources in India, water as finite resource, variability of water in time & space, history of water resources development, water infrastructure-problems and perspectives, present institutional framework for water management.

**b) Water laws:** Constitutional provisions, National Water Policy, riparian rights / ground water owner ship, prior appropriation, permit systems, acquisition and use of rights, scope for privatization. EPA 1986, MWRRA act.

**Unit2: Economics & Paradigm shift in water management**

**(6 Hrs)**

**a) Economics of water :** Water as economic good, intrinsic value, principles of water pricing & water allocation, capital cost, opportunity cost, internal rate of return, benefit cost analysis, principles of planning and financing of water resources project : Discussion on any two case studies.

**b) Paradigm shift in water management:**

Global and national perspectives of water crisis, water scarcity, water availability and requirements for human and nature, concepts of 'blue water', 'Green water', and 'virtual water', and their roles in water management. Sustainability principles for water management, framework for planning a sustainable water future.

**Unit 3: Basin scale flogy**

**(6 Hrs)**

**a) Estimation of surface water, estimation of ground water draft/recharge import/export of water (inter basin water transfer, interlinking of national river), recycling and reuse and storage, control of water logging, salinity, & siltation of storages.**

**b) Flood & Drought management:** causes of floods, structural and non-structural measures, mitigation plan, flood damage assessment, use of geoinformatics for flood management. Types of droughts, severity index, drought forecasting, damage assessment, mitigation plan, use of geoinformatics for drought management.

#### **Unit 4: Water demand and supply based management**

**(6 Hrs)**

- a) Consumptive & non consumptive demands, irrigation demand estimation, water utilization, irrigation efficiency, water management in irrigation sector.
- b) Demand estimation in hydro/thermal/nuclear power sector, estimation & forecasting of water demands of domestic & industrial sector, navigation and recreational water demands.

#### **Unit 5: Environmental and social aspects**

**(6 Hrs)**

- a) **Environmental management:** protection of vital ecosystem, water requirements for environmental management, aquaculture, minimum flows, environmental flow, water quality management for various uses.
- b) **Social impact of water resources development:** direct/ indirect benefits, employment generation, industrial growth, agro-industry, enhanced living standards, education & health, co-operative movement, management of rehabilitation & resettlement, interstate dispute of water sharing and tribunals, sectorial conflicts.

#### **Unit6: Basin planning & Watershed management**

**(6 Hrs)**

- a) Perspective plan for basin development & management, Decision support system for Integrated Water Resources Management (IWRM), use of data driven techniques like Artificial Neural Networks, Genetic programming, Model Tree in water resources planning, development & management.
- b) **Watershed Management:**  
Watershed definition, classification of watersheds, integrated approach for watershed management, role of RS & GIS in watershed management, soil and water conservation-necessity- soil erosion-causes- effects-remedial measures, contour bunding-strip cropping-bench terracing-check dams, farm ponds, percolation tank.

#### **Text Books:**

- 1) Water Resources Systems Engg, D. P. Loucks, Prentice Hall
- 2) Water Resources Systems Planning and Management, Chaturvedi, M.C. Tata McGraw Hill
- 3) Economics of Water Resources Planning, James L.D and Lee R.R, McGraw Hill
- 4) Water resources hand book; Larry W. Mays, McGraw International Edition
- 5) Design of Water Resources Systems, Arthur Mass, MacMillan 1962
- 6) Water resource system, Pramod .R. Bhawe - Narosa Publication

### Reference Books:

1. Economics of Water Resources Planning, L. D. James & R.R.Leo, McGraw Hills, NY 1971.
2. Water Resources Systems Engineering, W. A. Hill & J. A. Dracup.
3. Water shed Management – B.M. Tideman
4. Watershed management –J. V. S. MURTY, new Age International Publisher.
5. Integrated Watershed Management Perspectives and Problems - Beheim, E., Rajwar, G.S., Haigh, M., Krecek, J. (Eds.) , Springer Publication.
6. Managing Water in River Basins: Hydrology, Economics and Institutions -- M. Dinesh Kumar, Publisher: Oxford University Press
7. Water Resources Design Planning Engg. and Economic; Edward Kuiper, Butterworth & Co.
8. ANN in Hydrology; Govinda Raju & Ramachandra Rao; PHI
10. Integrated Water Resources Management in Practice: Better Water Management for Development - R. L. Lenton, Mike Muller , Publisher Earthscan.
11. Sustainability of Integrated Water Resources Management - Editors: Setegn, Shimelis Gebriye, Donoso, Maria Concepcion (Eds.) Publisher Springer International Publishing .
12. Integrated Water Resources Management in the 21st Century: Revisiting the paradigm -Pedro Martinez-Santos, Maite M. Aldaya, M. Ramón Llamas, Publisher CRC Press, Taylor & Francis Group.
13. Key Concepts in Water Resource Management: A Review and Critical Evaluation - Jonathan Lautze, publisher Routledge.
14. Water Management – Jaspal Singh, M.S.Acharya, Arun Sharma – Himanshu Publication.

### e – Resources:

1. [nptel.iitm.ac.in/courses/webcourse-contents / IISc-Bang/water resource management](http://nptel.iitm.ac.in/courses/webcourse-contents/IISc-Bang/water%20resource%20management).

## 401 005 Elective II (3) TQM and MIS in Civil Engineering

**Teaching scheme:**

**Lectures: 3 Hrs/week**

**Examination scheme:**

**In semester exam: 30 marks---1 Hr.**

**End semester exam: 70 marks—2.5 Hrs.**

### **Unit I: Quality in Construction**

**(6 Hrs)**

- a) Quality – Various definitions and interpretation. Importance of quality on a project in the context of global challenges, Factors affecting quality of construction, Reasons for poor quality & measures to overcome, Contribution of various Quality Gurus(Juran, Deming, Crosby, Ishikawa).
- b) Evolution of TQM- QC, TQC, QA, QMS, TQM.

### **Unit II: TQM & Six Sigma**

**(6 Hrs)**

- a) TQM – Necessity, advantages , 7QC tools, Quality Function Deployment(QFD).
- b) Six sigma – Importance, levels.
- c) Defects & it's classification in construction. Measures to prevent and rectify defects.

### **Unit III: ISO & Quality Manual**

**(6 Hrs)**

- a) Study of ISO 9001 principles.
- b) Quality manual – Importance, contents, documentation. Importance of check-lists in achieving quality. Typical checklist for concreting activity, formwork activity, steel reinforcement activity.
- c) Corrective and Preventive actions, Conformity and NC reports.

### **Unit IV: Management Control & Certifications**

**(6 Hrs)**

- a) Benchmarking in TQM, Kaizen in TQM.
- b) Quality Circle.
- c) Categories of cost of Quality.
- d) CONQAS, CIDC-CQRA certifications.

### **Unit V: Techniques in TQM Implementation and awards**

**(6 Hrs)**

- a) 5 'S' techniques.
- b) Kaizen.
- c) Failure Mode Effect Analysis (FMEA).

- d) Zero Defects.
- e) National & International quality awards- Rajeev Gandhi Award, Jamuna Lal Bajaj Award, Golden Peacock Award, Deming Prize, Malcolm Baldrige award.

## **Unit VI: MIS**

**(6 Hrs)**

- a) Introduction to Management Information systems (MIS) Overview, Definition.
- b) MIS and decision support systems, Information resources, Management subsystems of MIS, MIS based on management activity whether for operational control, management control, strategic control.
- c) Study of an MIS for a construction organization associated with building works.

### **Text Books:**

1. Total Quality Management-- Dr. Gunmala Suri and Dr. Puja Chhabra Sharma—Biztantra.
2. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ. Company.
3. Total Quality Management - Dr. S.Rajaram and Dr. M. Sivakumar—Biztantra.
4. Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.

### **Reference Books:**

1. Juran's Quality Handbook – Juran Publication. Importance of quality on a project in the context of global challenges. Importance of quality on a project in the context of global challenges.
2. Management –Principal, process and practices by Bhat – Oxford University Press.
3. Financial management by Shrivastava- Oxford University Press.
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ. Co.
5. Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.

### **E- Sources:**

[www.nptel.ac.in](http://www.nptel.ac.in) , [www.mobile.enterpriseappstoday.com](http://www.mobile.enterpriseappstoday.com)

## 401 005 Elective II (4) Earthquake Engineering

**Teaching scheme:**  
**Lectures: 3 Hrs/week**

**Examination scheme:**  
**In semester exam: 30 marks---1 Hr.**  
**End semester exam: 70 marks—2.5 Hrs.**

### Unit I

#### **Introduction to earthquakes: (6 Hrs.)**

Geology of earth, configuration of tectonic plates in a globe, influence of Geology on earthquake, behavior of plates, their motion and effects, causes of earthquake and their Characteristics, Earthquake parameters, magnitudes, intensity, scales, classification of earthquake seismic zoning of India, seismic coefficients for different zones, .Lessons from past earthquake: - Study of damages caused due to past, earthquakes in/ outside India and remedial measures.

### Unit II (6 Hrs.)

#### **Theory of vibrations:**

Vibrations - definition, causes, classifications. Single Degree of Freedom systems (SDOF) - Free, forced, damped, un-damped vibrations with basic examples. Introduction to Multi-degrees of Freedom systems (MDOF) - derivations of related equations and solutions to two degree and three degree of freedom systems.

### Unit III (6 Hrs.)

#### **Static analysis of earthquake forces:**

Introduction to IS1893 (Part-I): Seismic design Philosophy, provision, Seismic coefficient method.

### Unit IV (6 Hrs.)

#### **Dynamic analysis of earthquake forces:**

Response Spectra, estimation of story shear, effect of unsymmetrical geometry and masses, mass center and stiffness center, estimation of story shear for symmetrical and torsion for unsymmetrical buildings. Effect of infill masonry and shear walls.

## Unit V

(6 Hrs.)

### Earthquake force calculation and analysis and design of frames

Estimation of combined effect of lateral forces and vertical loading on multi storeyed frames. Design any intermediate continuous beam of the frames for combined effect of loadings, Concept of ductile detailing, IS 13920 provisions for RC frame.

## Unit VI

(6 Hrs.)

Introduction of different control systems: Passive control: base isolation and active control: bracing system. Strengthening and Retrofitting techniques, methodology of retrofitting for walls, slabs roofs columns, foundations etc. for buildings in stones, bricks, RCC. Introduction to Disaster Management: Types of Disaster, Phases of disaster management, Disaster rescue, psychology and plan of rescue operations.

### Notes:

Every design should confirm to latest versions of IS 1893, 4326, 13920, 13827, 13828, 13935

### Text Books:

1. Earthquake resistance design of structure by Duggal- Oxford University Press.
2. Earthquake – Resistant Design of Building Structures-Dr. Vinod Hosur-- Wiley India.
3. Earthquake Tips NICEE, IIT, Kanpur.
4. Elements of Earthquake Engineering by Jaikrishna and Chandarsekaran.
5. Earthquake resistant design of structures- Agarwal, Shrikhande, PHI learning.

### Reference Books:

1. Dynamics of structure by Clough R.W. and Penzin J. McGraw Hill Civil Engineering Series.
2. Dynamics of structure by Anil Chopra, Prentice Hall India Publication.
3. Dynamics of structure by Mario Paz, CBSPD Publication.
4. Geo-technical Earthquake Engineering by Kramer S. L. Prentice Hall India Publication.
5. Introduction to Structural Dynamics by John M. Biggs.
6. Mechanical Vibrations by V. P. Singh.
7. Relevant Latest Revisions of IS codes.



## 401 005 Elective II (5)- Advanced Geotechnical Engineering

### Teaching scheme:

Lectures: 3 hours/week

### Examination scheme:

In semester exam: 30 marks---1 hour

End semester exam: 70 marks—2.5 hours

### Unit I

(6 Hrs.)

(a) Soil classification Identification and classification, criteria for classifying soil - classification on the basis of grain size, plasticity, symbolic & graphic presentation. Classified soils and engineering properties. (b) Soil structure & clay minerals Clay minerals, clay water relations, clay particle interaction, soil structure & fabric, granular soil fabric.

### Unit II

(6 Hrs.)

(a) Earth pressure theory Earth pressure theories for calculation of active and passive pressure, Rankines and coulombs earth pressure theories, analytical and graphical methods. (b) Design of earth retaining structures Design of gravity and cantilever retaining walls, design - cantilever sheet pile walls, anchored sheet pile walls, timbering and bracing for open cuts.

### Unit III

(6 Hrs.)

(a) Geosynthetics Geosynthetics- types, functions, properties and functional requirements. Application of geosynthetics in geoenvironment. (b) Reinforced soil Mechanism, reinforcement soil – interaction. Applications – reinforcement soil structures with vertical faces, reinforced soil embankments. Reinforcement soil beneath unpaved roads, reinforcement of soil beneath foundations. Open excavation and slope stabilization using soil nails.

### Unit IV

(6 Hrs.)

(a) Soil behavior under dynamic loads Soil behavior under static and dynamic loads. Acceptable levels of strain under static and dynamic loading. Soil properties relevant for dynamic loading and its determination. (b) Machine foundations: Types of machine foundations, design criteria, methods of analysis – elastic half space method, linear elastic weightless spring method. Evaluation of soil parameters. Design procedure for a block foundation for cyclic loading and impact loading.



**Unit V****(6 Hrs.)**

Ground Improvement In-situ ground improvement by compaction piles, dynamic loads, sand drains, grouting, deep mixing, inserting reinforcement elements, freezing soil, and vibroflotation.

**Unit VI****(6 Hrs.)**

Rheology Rheological elements, basic and composite rheological models. Examples of compound models used to explain different soil phenomena; such as secondary consolidation, creep etc.

**Reference Books:**

1. Physical and Geotechnical properties of soils- Joseph E. Bowels, Tata Mac-Grawhill.
2. Advance Soil Mechanics – Braja Mohan Das- Tata Mc- Grawhill.
3. Geotechnical Engineering by Shashi K. Gulati & Manoj Datta – Tata Mc-Grawhill.
4. Basic and Applied Soil Mechanics- Gopal Ranjan & A.S. Rao- New Age Publication.

**Codes:**

1. I.S .Codes 1. IS: 1892-1979 – “Code of Practice for Subsurface Investigation for Foundation”.
2. 2. IS: 2131-1981 (Reaffirmed 1997), “Method for Standard penetration Test for Soils”.

**Handbooks:**

1. Bolt, Bruce A.(1999),”Earthquakes”, W. H. Freeman.
2. Baghi, A., (1994)” Design, Construction and Monitoring of Landfills.” John Wiley & Sons.
3. Day. R.W.(2002),”Geotechnical Earthquake Engineering Handbook”,McGraw Hill.

**e -Resources:**

1. Website [www.nptel.iitm.ac.in](http://www.nptel.iitm.ac.in)

## 401006 Project Phase-I

**Teaching Scheme:**

**Tutorial: 2 Hrs/week**

**Examination Scheme:**

**TW: 50 Marks.**

Project phase I Term Work will be evaluated for an individual student based on the seminar presented on the work done in first semester and submission of the report. If the student fails to present the seminar and submit the report, he / she will be marked absent in project examination. The project work phase I shall be consist of any one of the following nature in Civil Engineering related subjects.

1. Experimental investigation.
2. Software development.
3. Benefits cost economic analysis.
4. Case study with own design.
5. Working model design and fabrication.
6. Case study with development of methodology using soft computing tools.

It is mandatory to present a seminar in presence of Internal and External Examiners and submit preliminary project report based on work done in first semester. The report shall contain finalization of topic, literature survey, planning schedule/ flow chart for completion of project. The report shall be typed or printed and hard/spiral bound. The project work to be taken up individually or in groups. The group shall not be of more than 4 students. References shall be mentioned at the end as per universal standards as mentioned in any international journal of professional body.

### **Format of project report: Sequence of pages:**

- |                     |                     |                      |               |
|---------------------|---------------------|----------------------|---------------|
| i) Front Cover Page | ii) Certificate     | iii) Acknowledgement | iv) Synopsis  |
| v) Contents         | vi) Notations       | vii) List of Tables  | viii) List of |
| Figures             | ix) List of Graphs. |                      |               |

Chapter 1 Introduction (This consists of: 1.1 Introduction of the Project Work; 1.2 Problem Statement, 1.3 Objectives and 1.4 Scope of the Project Works, 1.5 Research Methodology, 1.6 Limitations of study, 1.7 Expected outcome.

Chapter 2 Literature Review from minimum 10 articles (It shall include theoretical support, details regarding work done by various persons, methods established, any new approach. It should preferably highlight the development in the field of research chronologically as reflected from books, journals etc.).

Chapter 3 Planning Schedule/ Flow Chart For Completion of Project References and Bibliography (The references and bibliography shall include name of author/code/manual/book, title of paper/code/manual/book, name of the journal, month & year of publication, volume number/ISBN number, page number x-y. The references and bibliography shall be as per universal standards as mentioned in any international journal of professional body).

**Report Printing details:**

1. Report shall be typed on A4 size Executive Bond paper with single spacing preferably on Both sides of paper.
2. Margins: Left Margin: 37.5 mm, Right Margin: 25 mm, Top Margin: 25 mm, Bottom Margin: 25 mm.
3. Give page number at bottom margin at center.
4. Size of Letters: Chapter Number: 16 font size, Times New Roman in Capital Bold Letters, Chapter Name: 12 Font size in Capital Bold Letters, Main Titles (1.1, 2.5 etc): 16 Font size in Bold Letters Sentence case, Sub Titles (1.1.5, 4.5.1 etc): 14 Font size in Bold Letters-Sentence case. All other matter: 12 Font size sentence case.
5. No blank sheet be left in the report.
6. Figure name: 12 Font size in sentence case Bold- Below the figure.
7. Table title -12 font size in sentence case- Bold-Above the table.

## Semester-II

Savitribai Phule Pune University Board of Studies in Civil Engineering B.E.

Civil 2015 Course (w. e. f. June 2018)

### 401007 Dams and Hydraulic Structures

#### Teaching Scheme:

Lectures: 3 hours/week

Practical: 2 hours/week

#### Examination Scheme:

In-sem: 30 marks (1 Hour)

End-sem :70 marks (2.5 Hours)

Oral : 50 marks

#### Unit I

(4 Hrs.)

##### a) Introduction to dams

Introduction, Historical development of dams, Different terms related to dams, Selection of site for dam, Factors governing selection of type of dam, Classification of dams, Classification based on purpose, Classification based on materials, Classification based on size of project, Classification based on hydraulic action, Classification based on structural action, Dams and earthquakes, Dams and social issues, Large dams verses small dams, Displacement and rehabilitation, Dams and climate change.

##### b) Dam Safety and Instrumentation

Introduction, Objectives of dam safety and instrumentation, Types of measurements, Instrumentation data system, Working principles and functions of instruments, Selection of Equipment's, Different Instruments, Piezometers, Porous tube piezometer, Pneumatic piezometer, Vibrating wire piezometer, Settlement measurement system Vibrating wire settlement cell, Magnetic settlement system, Inclinator, Joint meter, Pendulums, Inverted Pendulum, Hanging Pendulum, Automatic pendulum coordinator, Vibrating wire pressure cell, Extensometer, Embedment strain gauge, Temperature gauge, distributed fiber optics temperature tool, seismograph.

#### UNIT 2

(7 Hrs.)

##### a) Gravity Dams

Introduction, Components of gravity dam, Conditions favoring gravity dams, Forces acting on gravity dam, Combinations of loading for design, Seismic analysis of dam, Terms related to seismic analysis, Determination of Seismic forces (Zangar's method), Effect of horizontal earthquake acceleration, Effect of vertical earthquake acceleration, Stress analysis in gravity dam (Only concept, no derivations), Vertical or normal stress, Principal stresses, Shear

stress, Middle third rule, Modes of failure of gravity dam, Elementary profile of gravity dam, Concept of low and high gravity dams, Various Design methods of gravity dam (Introduction only)— Details of Gravity method or 2 D method, ,Construction of gravity dams, Colgrout masonry, Roller Compacted Concrete (R.C.C.), Temperature control in mass concreting, Crack formation in gravity dam, Control of crack formation in dams, Construction joints, Keys, Water seal, Retrofitting.

**b) Arch Dam and Other Dams (Introduction only)**

Introduction, Concept of Arch Dam, Conditions favoring an arch dam, Classification of an arch dam, Constant angle arch dam, Constant radius arch dam, Variable radius arch dam, Arch gravity dam, Double curvature arch dam, Buttress dams, Advantages of Buttress dams, Limitations of Buttress dams, Types of buttress dams.

**Unit III**

**(7 Hrs.)**

**a) Spillway and Gates [6 Lectures]**

Introduction, Location of Spillway, Different key levels and heads in spillway, Spillway Capacity, Components of spillway, Approach channel, Control structure, Discharge channel, Energy dissipation device, Tail channel, Classification of spillway, Classification based on operation, Main or service spillway, Auxiliary spillway, Emergency spillway, Classification based on gates, Gated spillway, Ungated spillway, Classification based on features, Straight drop spillway(Free overflow spillway), Saddle spillway, Side channel spillway, Overflow or ogee spillway, Chute or open channel or trough spillway, Shaft or morning glory spillway, Siphon spillway, Conduit or tunnel spillway, Stepped spillway,

Design of Ogee spillway or overflow spillway, Shape of crest, Equations for spillway profile on upstream and downstream, Energy dissipation below spillway, Classification of energy dissipation devices, Energy dissipation in stilling basin, Stilling basin, Components of stilling basin, Types of stilling basins, Indian standard stilling basins, Energy dissipation through buckets, Solid roller bucket, Slotted roller bucket, Ski jump bucket, Correlation between jump height and tail water depth.

**b) Spillway Gates**

Introduction of Spillway gates , Classification of spillway crest gates, Classification based on function, Classification based on movement of gates, Classification based on special features, Introduction to automatic gates, Maintenance of gates, Inspection of gates.

## Unit IV

(7 Hrs.)

### a) Earth Dam

Introduction, Conditions favoring an earth dam, Limitations of earth dam, Classification of earth dam, Classification based on---materials, method of construction, height; Selection of type of earth dam, Components of an earth dam, Requirements for safe design of earth dam, Hydraulic (Seepage) Analysis, Plotting of seepage line, Case 1: Homogeneous earth dam with horizontal drainage blanket, Determination of seepage discharge using phreatic line.

**Case II:** Composite earth dam with casing and hearting, Properties of phreatic line, Determination of seepage discharge through earth dam using flownet, Structural stability analysis of homogeneous and zoned earth dam, Forces acting on earth dam, Method of stability analysis of an earth dam, Procedure of analysis by Swedish slip circle method, Fellenius Method of Locating Centre of Critical Slip circle, Stability analysis for foundation, Failure of earth dam, Classification of failure of earth dams, Hydraulic Failure, Seepage failure, Structural failure, Seepage control in earth dams, causes of seepage, Seepage control measures, Construction of earth dam,

### b) Diversion head works

Introduction, Function of diversion headworks, Selection of site for diversion headworks, Layout of diversion headworks, Components of diversion headworks, Design of weir on permeable foundation, Criteria for safe design of weir floor, Brief introduction to Bligh and Lane's theory, Khosla's theory based on potential theory approach, Khosla's theory of independent variables, Design criteria of weirs on permeable foundations, Checks for stability and safety of weirs.

## Unit V

(6 Hrs.)

### a) Canals

Introduction, Classification of canals, Classification based on alignment, Classification based on soil, Classification based on source of supply, Classification based on discharge, Classification based on lining, Classification based on excavation, Components of canal, Data required for canal design, Selection of canal alignment, Design of stable canal in alluvial beds, Kennedy's theory, Design of canal by Kennedy's theory, Limitations of Kennedy's theory, Lacey's regime theory, Design of canal by Lacey's theory, Canal lining, Need of canal lining, Requirements of lining material, Classification of canal lining, Hard surface lining including Ferrocement lining, Soft surface lining, Buried lining, Advantages of canal lining, Design of lined canal, Benefit – cost analysis for canal lining.

## **b) Canal Structures**

**Canal falls** Introduction, Necessity of canal fall, Selection of site for canal fall, Classification of canal fall, Types of falls, Free fall or open fall, Notch fall, Ogee Fall, Rapid Stepped fall, Straight glacis fall, Sarda fall, Semi pressure fall, Baffle or Englis Fall, Montague fall Siphon well or cylinder fall, Pressure or closed conduit fall, Shaft or Pipe fall, Selection of type of fall, **Canal outlets-** Introduction of Canal outlet or module, **Canal escapes-** Introduction of Escapes, Significance of canal escape, **Canal regulators--**Canal regulators.

## **Unit VI**

**(5 Hrs.)**

### **a) C. D. Works**

Introduction, Necessity of cross drainage works, Selection of site for Cross Drainage work, Data required for design of Cross Drainage work, Classification of Cross Drainage works, Drain over canal-Siphon, Super passage, Canal over drain—Aqueduct, Siphon aqueduct, Canal and drain water mixed in each other--Level crossing, Inlet and Outlet, Selection of suitable type of C. D. works, Design considerations for cross drainage works.

### **b) River Training Structures**

Introduction, Classification of rivers, Classification based on topography, regime, alignment, source, Behaviour of rivers, River training, Objectives of river training, Classification of river training, purpose, orientation, River training structures, Embankment or Levee, Guide banks, Groynes or spurs, Artificial cut off, Pitched island, Submerged sill or dykes, Closing dykes.

## **Term Work (A+B+C)**

### **A) Analysis /Design Assignments. (Compulsory)**

- 1) Stability analysis of gravity dam
- 2) Design of profile of spillway and energy dissipation device below the spillway
- 3) Stability analysis of zoned earthen dam
- 4) Analysis of weirs on permeable foundations.
- 5) Design of unlined and lined canal.

### **B) Site visits and reports with photographs (compulsory)**

1. Gravity dam.
2. Earth dam.
3. D. work/ Canal structure(s)/Weirs/Barrage.



**C) Review of any one case study of failure of hydraulic structure from the published literature or patent related to Hydraulic structures (in a group of five students).**

**Note:-**

Visit report should consist of Name of project, date of visit, need and practical significance of project, salient features of project, technical details of project, detailed description and figures of different components of project, special features of project, the technical, social, financial and environmental impact of project on downstream and upstream, photographs of technical details of visit, if allowed. If not allowed for technical details, the photograph near board of project or site as a proof of visit.

**Reference Books :-**

1. Design of Small Dams- United States Department of the Interior, Bureau of Reclamation revised reprint 1974, Oxford and IBH Publishing Co.
2. Irrigation and Water Resources Engineering- Asawa G.L- New Age International (P) Ltd. Publishers, first ed, 2005.
3. Irrigation Engineering and Hydraulic Structures- Garg S.K- Khanna Publishers N.D. 13th ed, 1998.
4. Design Textbook in Civil Engineering: Volume Six: Dams- Leliavsky, Serge – Oxford and IBH Publishing Co. Pvt. Ltd., 1981.
5. Roller Compacted Concrete Dams- Mehrotra V.K- Standard Publishers Distributors, Delhi, 1st ed, 2004.
6. Irrigation, Water Resources and Water Power Engineering- Modi, P.N. - Standard Book House, New Delhi, 2nd ed, 1990.
7. Irrigation and Water Power Engineering - Punmia B.C. - Laxmi Publication.

**I.S. Codes:**

1. I.S. 8605 – 1977 (Reaffirmed 1998), Code of practice for construction of masonry in dams, third reprint, July 1999, B.I.S. New Delhi.
2. I.S. 6512-1984 (Reaffirmed 1998), Criteria for design of solid gravity dams, first revision, first reprint, September, 1998, B.I.S. New Delhi.
3. I.S. 457 – 1957 (Reaffirmed, 2005), Code of practice for general construction of plain and reinforced concrete for dam and other massive structures, sixth reprint, January 1987, B.I.S. New Delhi.



4. I.S. 10135 – 1985, Code of practice for drainage system for gravity dams, their foundations and abutments, first revision, B.I.S. New Delhi.
5. I.S. 14591 – 1999, Temperature control mass concrete for dams – guidelines, B.I.S.
6. I.S. 11223 – 1985 (Reaffirmed 2004), Guidelines for fixing spillway capacity, edition 1.2 (1991-09), B.I.S. New Delhi.
7. I.S. 6934 – 1998 (Reaffirmed 2003), Hydraulic design of high ogee overflow spillways – recommendations, first revision, B.I.S. New Delhi.
8. I.S. 11155- 1994, Construction of spillways and similar overflow structures – Code of practice, B.I.S. New Delhi.
9. I.S. 5186 – 1994, Design of chute and side channel spillway – criteria, first revision, B.I.S. New Delhi.
10. I.S. 10137- 1982 (Reaffirmed 2004), Guidelines for selection of spillways and energy dissipaters, B.I.S. New Delhi.
11. I.S. 4997 – 1968 (Reaffirmed 1995) Criteria for design of hydraulic jump type stilling basins with horizontal and sloping apron, sixth reprint, January, 1998, B.I.S. New Delhi.
12. I.S. 7365-1985, Criteria for hydraulic design of bucket type energy dissipaters, first revision, B.I.S. New Delhi.

## 01 008      Quantity Surveying, Contracts & Tenders

### Teaching scheme:

Lectures: 3 Hrs/week

Practical: 2 Hrs/week

### Examination scheme:

In semester exam: 30 Marks---1 Hr.

End semester exam: 70 Marks—2.5 Hrs.

Oral: 50 Marks

### Unit I

(6 Hrs.)

#### Introduction and Approximate Estimates:

- a) **Introduction to estimates and related terms:** Definition of estimation and valuation. Significance (application) of the Course. Purpose of estimation. Type of estimates, data required for estimation as a pre requisite. Meaning of an item of work, and enlisting the items of work for different Civil Engineering projects. Units of measurement. Mode of measurement of building items/ works. Introduction to components of estimates: face sheet, abstract sheet (BOQ), measurement sheet, Rate Analysis, lead statement. Provisional sum & prime cost items, contingencies, work charge establishment, centage charges. Introduction to D. S. R.
- b) **Approximate Estimates:** Meaning, purpose, methods of approximate estimation of building & other civil engineering projects like roads, irrigation/ water supply, sanitary engineering, electrical works. (Theory & Numericals).

### Unit-II

(6 Hrs.)

#### Taking out quantities & Detailed estimate:

- a) **Detailed estimates:** Factors to be considered while Preparing Detailed Estimate, Detailed estimate of R.C.C framed structures using IS 1200, Concept of Estimation of Load Bearing Structure (PWD & Centre Line Method).
- b) **Bar Bending Schedule:** Preparing Bar Bending Schedule for all RCC members of building.

### Unit-III

(6 Hrs.)

#### Specifications and Rate Analysis:

- a) **Specifications:** Meaning & purpose, types. Drafting detailed specifications for materials, quality, workmanship, method of execution, mode of measurement and payment for major items like, excavation, stone/ brick masonry, plastering, ceramic tile flooring, R.C.C. work.

**b) Rate Analysis:** Meaning and factors affecting rate of an item of work, materials, sundries, labour, tools & plant, overheads & profit. Task work or out turn, factors effecting task work. Working out Rate Analysis for the items mentioned in specifications above.

#### **Unit IV**

**(6 Hrs.)**

##### **Valuation:**

**a) Valuation:** Purpose of valuation. Meaning of price, cost and value. Factors affecting

‘Value’. Types of value: only Fair Market Value, Book Value, Salvage/ Scrap Value, Distressed Value and Sentimental Value. Concept of free hold and lease hold property. Estimation versus valuation. Methods of depreciation & obsolescence, Sinking Fund, Years Purchase.

**b) Methods of Valuation of Building:** Rental Basis, Land & Building basis, Direct Comparison Method, Profit based method, Belting of Land, Development method.

#### **Unit V**

**(6 Hrs.)**

##### **Tendering and Execution of Works:**

**a) Tenders:** Definition. Methods of inviting tenders, tender notice, tendering procedure, Pre and post qualification of contractors, tender documents. 3 bid/ 2 bid or single bid system. Qualitative and quantitative evaluation of tenders. Comparative statement, Pre-bid conference, acceptance/ rejection of tenders. Various forms of BOT & Global Tendering, E-tendering.

**b) Methods of Executing Works:** PWD procedure of work execution, administrative approval, budget provision, technical sanction. Methods of execution of minor works in PWD: Piecework, Rate List, Daily Labour. Introduction to registration as a contractor in PWD.

#### **Unit VI**

**(6 Hrs.)**

##### **Contracts and Arbitration:**

**a) Contracts:** Definition, objectives & essentials of a valid contract as per Indian Contract

Act (1872), termination of contract. Types of contracts: only lump sum, item rate, cost plus.

**Conditions of contract:** General and Specific conditions. Conditions regarding EM, SD, and time as an essence of contract, conditions for addition, alteration, extra items, testing of materials, defective work, subletting, etc. Defect liability period, liquidated damages, retention money, interim payment or running account bills, advance payment, secured advance, final bill.

- b) Arbitration:** Introduction to Arbitrations as per Indian Arbitration & Conciliation Act (1996) Meaning and need of arbitration, qualities and powers of an Arbitrator.

### **Term Work:**

**The following exercises should be prepared and submitted:**

1. Report on contents, use of current DSR & Drafting detailed specification for major items of works.
2. Working out quantities using C-L and PWD method for a small single storied load bearing structure up to plinth and Preparing Abstract Sheet using DSR(Regional)
3. Detailed Estimate of a single storied R.C.C framed building using D.S.R.
4. Working out quantities of steel reinforcement for a column footing, a column, a beam and a slab by preparing bar bending schedule.
5. Working out rate analysis for the items as in the specifications of Assignment No. 1.
6. Preparing Valuation of a Residential building and writing report using O-1 form.
7. Estimating quantities for any one of the following using appropriate software.
  - a) A Factory Shed of Steel Frame
  - b) Underground Water Tank
  - c) Pipe Culvert
  - d) Road / Railway Track/ Runway
8. Drafting of tender notice, Preparation of Schedule A & B and Conditions of Contract regarding time, labour payment, damages for RCC Framed Structure (Assignment No. 3) and collecting minimum of 3 tender notices of Civil Engineering Works.

Oral Examination: Based on the Term Work.

### **Reference Books:**

1. Estimating and Costing in Civil Engineering: Theory and Practice: B.N Dutta - S. Dutta & Company, Lucknow.
2. Estimating, Costing Specifications & valuation in Civil Engineering: M. Chakraborty.
3. Estimating and Costing: R. C. Rangwala - Charotar Publ. House, Anand.
4. Theory and Practice of Valuation: Dr. RoshanNamavati, Lakhani Publications.
5. Valuation Principles and Procedures: Ashok Nain, Dewpoint Publ.
6. Laws for Engineers : Dr. Vandana Bhat and Priyanka Vyas –Published by PRO-

CARE,5/B,/Sagarika Society,Juhu Tara Road,Juhu,Santacruz(W),Mumbai-400049  
procure@technolegal.org).

**Handbooks:**

1. Standard Contract Clauses for Domestic Bidding Contracts: Ministry of Statistics and Program Implementation, Government of India.
2. FIDIC Document: Federation International Des Ingenieurs Conseils i.e. International Federation of Consulting Civil Engineers, Geneva, Switzerland.
3. Indian Practical Civil Engineers' Handbook: P. N. Khanna, UBS Publi. Distri. Pvt. Ltd. (UBSDP).

**Codes:**

1. IS 1200 (Part 1 to 25): Methods of Measurement of Building & Civil Engg. Works.
2. IS 3861-1966: Method of Measurement of Areas and Cubical Contents of buildings.
3. D. S. R. (District Schedule of Rates) for current year.
4. PWD Redbooks, Vol 1 & 2.

e – Resources: nptel.iitm.ac.in

## 401 009 Elective III (1) Advanced Structural Design

### Teaching Scheme

Lectures: 3 hours/week

Practical: 2 hours/week

### Examination Scheme

Theory Examination:

In-sem : 30 marks (1 Hour)

End-sem: 70 marks (2.5 Hours)

**Term work: 50 Mark**

### Unit 1

(6 Hrs.)

**Cold-formed light gauge steel structural members:** Design of axially loaded compression members, tension members and beams (not more than two spans).

### Unit 2

(6 Hrs.)

**Frames:** Uniqueness theorem, lower bound and upper bound theorems, mechanisms, analysis and design of frames (single story), design of connections.

### Unit 3

(6 Hrs.)

**Composite deck slab:** Design of composite deck slab with cold form light gauge profile and shear connectors.

### Unit 4

(6 Hrs.)

**Yield line analysis and design of slabs:** Yield line theory, yield lines, ultimate moment along a yield line, principle of virtual work, analysis and design of slabs of different geometry, support conditions and loading conditions.

### Unit 5

(6 Hrs.)

**Elevated water tanks:** Analysis and design for gravity and earthquake loads (static analysis) for square, rectangular and circular water tanks (excluding Intze tank) supported on staging, design of staging and foundation system.

### Unit 6

(6 Hrs.)

**Shear walls:** Function, types, analysis and design of cantilever type shear walls.

**Note:** The designs should conform to the latest codal provisions.

**Term Work:**

- a) At least three plates showing the details of cold-formed light gauge steel sections used in compression, tension and flexural members
- b) At least three plates showing the details based on yield line analysis and design of slabs
- c) Sheet 1: Detailing of any one design problem from Unit 2 or Unit 3
- d) Sheet 2: Detailing of any one design problem from Unit 5 or Unit 6
- e) Report of two site visits covering the contents of the syllabus mentioned above.

**References:**

- 1). Design of Steel Structures, Ramachandra, Standard Publications New-Delhi
- 2). Structural and Stress Analysis, T.H.G. Megson, Butterworth-Heinemann
- 3). Design of Concrete Structures, J. N. Bandyopadhyay, PHI
- 4). Punmia, Reinforced Concrete Structures Vol. 1 and 2, Standard Book House NewDelhi.
- 5). Sinha and Roy., RCC Analysis and Design . S. Chand and Co. New-Delhi
- 6). Ramachandra, Design of Steel Structures Vol.-II Standard Publications New-Delhi.
- 7). Punmia,B. C. and Jain and Jain, Comprehensive Design of Steel Structures, Standard Book House
- 8) INSDAG publications

**401009 Elective=III (2) Statistical Analysis and Computational Methods in  
Civil Engineering**

**Teaching Scheme**

**Lectures : 3 hours/week**

**Practical: 2 hours/week**

**Examination Scheme**

**In-sem : 30 marks (1 Hour)**

**End-sem:70 marks (2.5.Hours)**

**Term work: 50 Mark**

**Unit I: (6 Hrs.)**

Numerical methods: Bisection method, False Position method, Newton Raphson, Secant method.

**Unit II: (6 Hrs.)**

Numerical Integration Need and scope, trapezoidal rule, Simpsons 1/3rd rule, Simpsons 3/8th rule, Gauss Quadrature method.

**Unit III: (6 Hrs.)**

Optimization techniques: Introduction to optimization techniques-concepts and applications, direct solution of linear equations-Gauss elimination and Gauss Jordan method. Iterative solution of linear equations- Gauss Seidel method.

**Unit IV: (6 Hrs.)**

Statistical methods: Introduction, collection, classification and representation of data, measures of central value (mean, median, mode), measures of dispersion, sampling.

**Unit V: (6 Hrs.)**

Probability and Probability distributions including Binomial, Poisson, Normal, test of hypothesis, chi-square test.

**Unit VI: (6 Hrs.)**

Correlation analysis, regression analysis. Coefficient of correlation, probable error, single and multiple regression, curve fitting, Interpolation and extrapolation.



**Term Work:**

1. One exercise on each unit.
2. Any two problems to be solved using c, c++, excel or using softwares like SPSS, minitab, etc.
3. One exercise on formulation and solution of an optimization problem applicable to any field of Civil Engineering.

**Reference Books:**

1. Statistical methods – S.P.Gupta.
2. Probability and Statistics for Engineers – Richard A Johnson
3. Probability and Statistics for Science and Engineering – G Shankar Rao.
4. Numerical Methods – E Balagurusamy.
5. Numerical methods for Engineers – S. Chapra, R.P.Canale.
6. Higher Engg. Mathematics – B.S. Grewa.

## 401009 Elective III (3): Hydro Power Engineering

### Teaching Scheme

Lectures: 3 hours/week

Practical: 2 hours/week

### Examination Scheme

Theory Examination

In-sem: 30 marks (1 Hour)

End-sem: 70 marks (2.5 Hours)

Term work: 50 Marks

### Unit I

(6 Hrs.)

#### Energy Resources – Planning and Potential:

Power resources – Conventional and Nonconventional, Need and advantages, Overview of World Energy Scenario, energy and development linkage, Environmental Impacts of energy use, Green House Effect, Trends in energy use patterns in India, Hydropower development in India, Hydropower potential basin wise and region wise, investigation in hydropower plants.

### Unit II

(6 Hrs.)

#### Hydropower Plants:

Hydrological Analysis, Classification of hydropower plants based on hydraulic characteristics - Run of river plants, Storage or Valley dam plants, Pumped storage plants, Classification based on head, Classification based on operating function, Classification based on plant capacity, Classification based on nature of topography, Introduction to micro hydro, advantages and disadvantages, Principle Components of hydropower plants.

### Unit III

(6 Hrs.)

#### Load Assessment:

Estimation of electrical load on turbines. Load factor, Plant factor, peak demand and utilization factor, installed capacity, diversity factor, firm power, secondary power, load curve, load duration curve, Prediction of load and significance, Tariffs, Hydro-Thermal Mix, Combined Efficiency of Hydro-Thermal-Nuclear Power Plants.

### Unit IV

(6 Hrs.)

#### Water Conductor System and Powerhouse:

Water Conductor System – Alignment, Intake Structures- Location and Types, Trash Rack. Headrace tunnel/ Canal, Penstock and pressure shaft, Types of Powerhouses, Typical layout of powerhouse, Components, Power plant equipments, Instrumentation and control.

## Unit V

(6 Hrs.)

### **Turbines:**

Classification, Principles and design of impulse and reaction turbines, Selection of Turbine, Specific Speed, Governing of turbines, Water hammer, Hydraulic Transients and Surge tanks, Draft tubes, Cavitation.

## Unit VI

(6 Hrs.)

### **Economics of Hydroelectric Power:**

Hydropower - Economic Value and Cost and Total Annual Cost. Economic considerations – pricing of electricity, laws and regulatory aspects, Policies, Electricity act – 2003, Investment in the power sector, Carbon credits, Participation of private sector.

### **Term Work:**

Minimum eight assignments as per the list given below. **Assignments 1 and 10 are compulsory.**

1. Calculating the electricity bill of upper middle class family that uses various electrical appliances.
2. Determination of power output for a run of river plant with and without pondage.
3. Justification of economics of Pumped storage plants.
4. Design of Kaplan / Francis / Pelton turbine.
5. Determination of diameter of penstock using different methods.
6. Design of surge tank.
7. Design of straight conical draft tube.
8. Use of any software to calculate water hammer pressure.
9. Case study of any hydropower project.
10. Report based on visit to any micro/small/mega hydropower project

### **Reference Books:**

1. Water Power Engineering – M. M. Dandekar and K. N. Sharma, Vikas Publishing House.
2. Water Power Engineering – R. K. Sharma and T. K. Sharma, S. Chand and Co. Ltd.
3. Handbook of Hydroelectric Engineering – P.S. Nigam
4. Modern Power System Planning – Wang.
5. Hydropower Resources in India – CBIP.

6. Hydro Power Structures – R. S. Varshney.
7. Water Power Development – E. Mosonvi, Vol. I & II.
8. Hydro-electric Engineering Practice – G. Brown, Vol. I, II & III.
9. Hydro – Electric Hand Book – Creager and Justin.
10. Water Power Engineering – P. K. Bhattacharya, Khanna Pub., Delhi.
11. Water Power Engineering – M. M. Deshmukh, Dhanpat Rai Pub.
12. Manual of “Energy Group” of ‘PRAYAS’, an NGO.

## 401009 Elective-III: (4) Air Pollution and Control

### Teaching Scheme:

Lectures: 3 Hrs/week

Practical: 2 Hrs/week

### Examination Scheme:

Paper In-sem. 30 Marks (1 hr),

Paper End-sem : 70 Marks (2.5 hrs)

TW : 50 Marks

### Unit I

(6 hrs)

**Meteorological aspects:** Zones of atmosphere, Scales of meteorology, Meteorological parameters, Temperature lapse rate, Plume behaviour. Gaussian diffusion model for finding ground level concentration, Plume rise, Types & quality of fuels, Formulae for effective stack height and determination of minimum stack height as per CPCB norms.

### Unit II

(6 hrs)

**Ambient Air sampling and analysis:** Air pollution survey, basis and statistical considerations of sampling sites, devices and methods used for sampling of gases and particulates. Stack emission monitoring for particulate and gaseous matter, isokinetic sampling. Analysis of air samples chemical and instrumental methods. Emission inventory and source apportionment studies. Ambient air quality monitoring as per the procedure laid down by CPCB. National Ambient Air Quality Standards (NAAQS) 2009.

### Unit III

(6 hrs)

**Indoor air pollution:** Causes of air pollution, sources and effects of indoor air pollutants, factors affecting exposure to indoor air pollution, sick building syndrome. Investigation of indoor air quality problems, changes in indoor air quality, control of indoor air pollutants and air cleaning systems. Use of various plants to control indoor air pollution. Radon and its decay products in indoor air.

**Odour pollution:** Theory, sources, measurement and methods of control of odour pollution.

### Unit IV

(6 hrs)

**Control of air pollution:** By process modification, change of raw materials, fuels, process equipment and process operation. Control of particulate matters. Working principle and design of control equipment as Settling chamber, Cyclone, Fabric filter and Electro Static Precipitator. Control of gaseous pollutants. Combustion chemistry & control of air pollution from automobiles.

## Unit V

(6 hrs)

**Land use planning:** As a method of control. Economics of air pollution control: Cost/benefit ratio and optimization. Legislation and regulation: Air (Prevention and Control) Pollution Act, 1981. The Environment (Protection) Act 1986. Emission standards for stationary and mobile sources.

## Unit VI

(6 hrs)

**Environmental impact assessment and management:** Methodology for preparing environmental impact assessment (Identifying the sources of air pollution, calculating the incremental values, prediction of impacts and mitigation measures). Role of regulatory agencies and control boards in obtaining environmental clearance for project. Public hearing. Environmental impacts of thermal power plants, sugar and cement industry. Environmental management plan. The environmental rules 1999 (siting of industries).

### Term Work:

Term work shall consist of

- A. One assignment on each unit.
- B. Detailed industrial visit report on Sugar/Cement/Steel//Thermal/Rubber/Dairy industry with reference to air pollution Control device(s).

### Reference Books:

1. Air Pollution – H. V. N. Rao and M. N. Rao, TMH, Pub.
2. Air pollution – KVSG Murali krishna.
3. Air Pollution – Perkins.
4. Environmental Engineering – Davis, McGraw Hill- Pub.
5. Environmental Engineering – Peavy H.S and Rowe D.R, McGraw Hill- Pub.
6. Air Pollution – Stern.
7. Air Pollution Control – Martin Crawford.
8. Air Pollution Control: its origin and control, K. Wark, C.F. Warner & W.T.Davis .
9. Fundamentals of Air Pollution-Richard W. and Donald L. Academic Press.

### I.S. Codes:

1. I.S. 5182 (all parts), and
2. I.S. 15442 (2004)

**e – Resources:**

1. <http://nptel.iitm.ac.in/courses-contents/IIT Kanpur and IIT Madras>.
2. <http://cpcb.nic.in>
3. <http://moef.nic.in>

## 401009 Elective III (5): Finite Element Method in Civil Engineering

### Teaching Scheme:

Lectures: 3 hours/week

Practical: 2 hours/week

### Examination Scheme:

Theory Examination:

In-sem: 30 marks (1 Hour)

End-sem: 70 marks (2.5 Hours)

Term work: 50 Mark

### Unit I

(6 Hrs.)

Theory of elasticity: Strain-displacement relations, compatibility conditions in terms of strain, plane stress, plane strain and axisymmetric problems, differential equations of equilibrium, compatibility condition in terms of stresses, stress-strain relations in 2D and 3D problems.

### Unit II

(6 Hrs.)

General steps of the finite element method, Applications and advantages of FEM, concept of finite element for continuum problems, discretisation of continuum, use of polynomial displacement function, Pascal's triangle, convergence criteria.

Principle of minimum potential energy, formulation of stiffness matrix for truss element using variational principles.

### Unit III

(6 Hrs.)

Displacement function for 2D triangular (CST and LST) and rectangular elements, Use of shape functions, Area co-ordinates for CST element, Shape functions in cartesian and natural coordinate systems, shape functions for one dimensional element such as truss and beam, shape functions of 2D Lagrange and serendipity elements.

### Unit IV

(6 Hrs.)

Introduction to 3D elements such as tetrahedron and hexahedron. Iso-parametric elements in 1D, 2D and 3D analysis, Jacobian matrix, Formulation of stiffness matrix for 1D and 2D Iso-parametric elements in plane elasticity problem.

### Unit V

(6 Hrs.)

Formulation of stiffness matrix, analysis of spring assemblage, member approach for truss and beam element, node numbering, assembly of element equations, formation of overall banded matrix equation, boundary conditions and solution for primary unknowns, applications to truss and beam not involving unknowns more than three.



## Unit VI

(6 Hrs.)

Formulation of stiffness matrix using member approach for portal frame and grid elements, transformation matrix, applications to frame and grid not involving unknowns more than three.

### Termwork:

The Termwork shall be based on completion of assignments as given below.

1. At least one assignment on each unit.
2. One assignment based on FEM by using coding tools for
  - a) Formulation of stiffness matrix for any 1-D element
  - b) Formulation of stiffness matrix for any 2-D element
3. Finite Element Method -Software applications of any one of following cases using any standard available software.
  - a) Truss/ grid problem
  - b) Plane stress / plane strain problem

### Reference Books

1. A first course in the finite element method-Daryl L. Logon, Thomson Publication.
2. Nonlinear finite element analysis by Reddy- Oxford University Press.
3. Introduction to the Finite Element Method – Desai & Abel, CBS Publishers & Distributors, Delhi
4. Introduction to Finite Elements in Engineering – T.R. Chandrupatla & A.D. Belegundu Prentice Hall of India Pvt. Ltd.
5. Matrix, Finite Element, Computer & Structural Analysis – M. Mukhopadhyay, Oxford IBH Publishing Co. Pvt. Ltd.
6. Finite Element Analysis – Theory & Programming – C.S. Krishnmoorthy, TATA McGraw Hill Publishing Co. Ltd.
7. An Introduction to the Finite Element Method – J.N. Reddy, TATA Mc Graw Hill Publishing Co. Ltd.
8. Theory & Problems – Finite Element Analysis – Gorge R. Buchanan, Schaum's Outline series. TATA Mc Graw Hill Publishing Co. Ltd.
9. The Finite Element Method – O.C. Zien kiewicz, TATA Mc Graw Hill Publishing Co. Ltd.
10. Finite Element Analysis – S.S. Bhavikatti, New Age International (P) Ltd.

## 401 0010 Elective III (6): Airport & Bridge Engineering

### Teaching scheme

Lectures: 3 hours/week

Practical: 2 hrs

### Examination Scheme

In-Sem Exam: 30 marks 1 hour

End-Sem Exam: 70 marks 2.5 hrs

Termwork: 50 marks

### Unit 1:

(6 hrs)

#### Introduction:

Advantages and limitations of air transportation. Aeroplane component parts and important technical terms, Organizations related to Air Transportation (ICAO, FAA, AAI) Roles and Responsibilities.

#### Airport planning:

Aircraft characteristics, which influence judicious and scientific planning of airports, Selection of sites, survey and drawings to be prepared for airport planning, Air Travel Demand forecasting, Airport classification by ICAO.

### Unit 2:

(6 hrs.)

#### Airport layout:

Characteristics of good layout, runway configuration, airport obstruction, location of terminal buildings, aprons and hangers. Zoning requirements regarding permissible heights of constructions and landing within the airport boundary, Airport landslide planning, Navigation and landing aids – ILS, Air Traffic Control (ATC).

#### Design of Runways and taxiways:

Runway orientation, wind coverage, use of wind rose diagram, basic runway length, corrections for elevation, temperature and gradient as per ICAO and FAA recommendation, Taxiways – Concept, types, design criteria.

### Unit 3:

(6 hrs.)

#### Structural Design of Runways and taxiways:

Runway pavement design criteria, aircraft loading, Design methods for flexible and rigid runways, Airport drainage.

**Unit 4:****(6 hrs.)****Heliports**

Helicopter characteristics, planning of heliports - site selection, size of landing area, orientation of landing area, Heliport marking and lighting, Vertical Takeoff and Landing (VTOL).

**Unit 5:****(6 hrs.)****Bridge engineering:****Introduction:**

Classification of bridges, components of bridges, preliminary data to be collected during investigation of site for bridges, determination of discharge – empirical formula, direct methods, economical span, afflux, HFL, scour depth and clearance, locations of piers and abutments, factors influencing the choice of bridge super structure, approach roads.

**Loads on bridges:**

Brief specifications of different loads, forces, stresses coming on bridges, IRC load specification, requirements of traffic in the design of highway bridges.

**Substructure:**

Abutment, Piers, and wing walls with their types based on requirement and suitability.

**Unit 6:****(6 hrs)****Types of bridges****Various types of bridges:**

**Culvert:** Definition, waterway of culvert and types.

**Temporary bridges:** Definition, materials used brief general ideas about timber, floating and pantoon bridges.

**Movable Bridges:** Bascule, cut boat, flying, swing, lift, transporter and transverse bridges, their requirement and suitability.

**Fixed span bridges:** Simple, continuous, cantilever, arch, suspension, bowstring girder type and rigid frame and cable stayed bridges, materials for super structure.

**Bearing:** Definition, purpose and importance. Types of bearings with their suitability.

**Erection of bridge super structure and maintenance:**

Introduction to different techniques of erection of bridge super structure and maintenance of bridges.

**Term work:****Term work shall consist of: (Any eight)**

1. Recent Trends in Airport planning and design (report expected)
2. Assignment on study and use of Windrose Type 1 and 2 diagram
3. Assignment on Runway Design for length and related corrections
4. Structural Design of Flexible or Rigid Runway
5. Selection of Bridge site, alignment and collection of design data
6. Assignment on conditional assessment of existing Bridges
7. Seminar on one topic each in Airport Engineering or Bridge Engineering
8. Report on Guest lecture in Airport Engineering or Bridge Engineering
9. Site visit to Bridge site or Airport site

**Text Books:**

1. Bridge engineering – S. Ponnuswamy, Tata Mc Graw – Hill publishing co. Ltd. New Delhi.
2. Airport planning and design – S.K. Khanna , M.G. Arora , S.S. Jain, Nem Chand and Brothers, Roorkee.
3. Airport Engineering - Rangawala, Charotar publishing House, Anand 388001 (Gujrat)
4. Essentials of Bridge Engineering – D. Johnson and Victor, Oxford and IBH publishing Co. Pvt. Ltd. , New Delhi.
5. Bridge engineering – Rangawala, Charotar Publishing House, Anand –388 001.
6. Principles and practice of Bridge Engineering – S.P. Bindra, Dhanpatrai and Sons, Delhi.

## 401 010 Elective IV (1): Construction Management

### Teaching Scheme:

Lectures: 3 hours/week

Practical: 2 hours/week

### Examination Scheme:

Theory Examination:

In-sem : 30 marks (1 Hour)

End-sem: 70 marks (2.5.Hours)

Term work: 50 Mark

### Unit – I

(6 Hrs.)

#### Overview of construction sector:

Role of construction industry in infrastructure development, components of infrastructure sector, construction industry nature, characteristics, size, structure, role in economic development, construction management – necessity, applications, project management consultants – role, types, selection and appointment process, project overruns and means to combat them, project monitoring and reporting systems, managerial correspondence and communications, generation and identification of project investment opportunities. (\*At least 2 expert lectures by experts from field are to be conducted on above topics).

### Unit – II

(6 Hrs.)

Construction scheduling, work study and work measurement Construction scheduling. Construction project scheduling – purpose, factors affecting scheduling, time as a control tool, work breakdown structure, project work breakdown levels, line of balance technique, repetitive project management Work study and work measurement .

Definition, objectives, basic procedure of work study, symbols, activity charts, string diagrams, time and motion studies.

### Unit – III

(6 Hrs.)

Labour laws and financial aspects of construction projects Labour laws. Need and importance of labour laws, study of some important labour laws associated with construction sector- workmans compensation act 1923, Building and other construction workers act 1996, child labour act, interstate migrant workers act Financial aspects of construction projects. Capital investments: importance and difficulties, means of finance, working capital requirements, project cash flow projections and statements, project balance sheet, profit loss account statements.

#### **Unit – IV**

**(6 Hrs.)**

Elements of risk management and value engineering. Risk management. Introduction, principles, types, origin, risk control, use of mathematical models: sensitivity analysis, break even analysis, simulation analysis, decision tree analysis, risk identification, analysis and mitigation of project risks, role of insurance in risk management. Value engineering Meaning of value, value analysis, value engineering and value management, energy resources, consumption patterns, energy cost escalation and its impact.

#### **Unit – V**

**(6 Hrs.)**

Materials management and human resource management . Materials management Materials flow system, role of materials management in construction management and its linkage with other functional areas, vendor networking, buyer-seller relationships, eoq model and its variations, material codification and classification, concept of logistics and supply chain management, role of ERP in materials management – material resource information systems Human resource management. Human Resource in Construction Sector, Staffing policy and patterns, Human Resource Management Process, Human Resource Development Process, Performance Appraisal and Job Evaluation, Training and Career planning, Role of ERP in Human Resource Management – Human Resource Information System (HRIS).

#### **Unit – VI**

**(6 Hrs.)**

Introduction to artificial intelligence technique. Basic terminologies and applications in civil engineering (a) Artificial neural network (b) Fuzzi logic (c) Genetic algorithm.

#### **Term Work:**

1. Site Visit to a Construction project to study following documents and preparing a report –
  - a. Project Cash Flow Analysis.
  - b. Project Balance Sheet.
  - c. Work Break Down Structure.
  - d. Materials Flow System in the Project.
2. Scheduling of a Construction Project using Line of Balance Technique.
3. Assignment on Work Study on any two Construction Trades.
4. Assignment on EOQ Model and its variation.
5. Assignment on application of AI techniques in Civil Engineering.
6. Seminar on any one topic from above syllabus.

**Reference Books:**

1. Projects – Planning, Analysis, Selection, Implementation and Review, Prasanna Chandra, Tata McGraw Hill Publications.
2. Construction Management and Planning – B. Sengupta and H. Guha, Tata McGraw Hill Publications.
3. Civil Engineering Project Management – C. Alan Twort and J. Gordon Rees, Elsevier Publications.
4. Total Project Management – The Indian Context – P. K. Joy, MacMillian Publications.
5. Materials Management–Gopalkrishnan & Sunderasan, Prentice Hall Publications.
6. Human Resource Management – Biswajeet Pattanayak, Prentice Hall Publishers.
7. Laws for Engineers : Dr. Vandana Bhat and Priyanka Vyas –Published by PROCARE, 5/B, Sagarika Society, Juhu Tara Road, Juhu, Santacruz(W), Mumbai-400049 ([procure@technolegal.org](mailto:procure@technolegal.org)).
8. Labour and Industrial Laws – S. N. Mishra, Central Law Publications.
9. Artificial Neural Network – Venganarayanan – Prentice Hall.
10. Genetic Algorithm – David & Goldberg.
11. Fuzzy Logic & Engg Applications – Ross.
12. Principles of Construction Management by Roy Pilcher ( McGraw Hill)

**e-Resources:**

1. ERP Software-Builders Management Software.
2. Project mates Construction Software.

## 401 0010 Elective IV (2): Advanced Transportation Engineering

### Teaching scheme

Lectures: 3 hours/week

Practical: 2 hrs

### Examination Scheme

In-Sem Exam: 30 marks 1 hour

End-Sem Exam: 70 marks 2.5 hrs

Termwork: 50 marks

### Unit I

(6 hrs.)

**Transport System Planning:** Transportation planning process and types of surveys. Travel demand forecasting - trip generation, modal split analysis, trip distribution and route assignment analysis, Transportation System Management (TSM), application in Comprehensive Mobility Plan (CMP) and DPR.

### Unit II

(6 hrs.)

**Urban Transport Technology:** Classification- light, medium, mass and rapid transit system, Introduction to Intelligent Transportation System (ITS) and its components, Public Transport Policy. Introduction to BRT, Mono rail, Metro rail, Bullet train and Hyperloop. Concept of Integrated Inter Model Transit System and freight transportation.

### Unit III

(6 hrs.)

**A. Transport Economics & Financing:** Road user cost - Vehicle operations cost, running cost, value of travel time, road damage cost, accident cost. Economic evaluation – Benefit cost method, Net present value method, First year rate of return method, Internal rate of return method & comparison of various methods.

**B. Environmental Impact Assessment:** EIA requirement of highway projects, procedure and guidelines, pollution cost and concept of congestion pricing.

### Unit IV

(6 hrs.)

**Traffic Engineering:** Traffic studies, basic traffic theory, traffic analysis process, level of service, intersection studies- turning movements, grade separated intersection, signal design- IRC method and Webster's method, parking study and analysis, bicycle and pedestrian facility design, instrumentation of traffic monitoring.



## Unit V

(6 hrs.)

**Study of flexible pavement:** Philosophy of design and design criteria, design of flexible pavement using IRC 37-2012, Distresses in flexible pavement, evaluation of pavement – Benkelmen beam, Falling Weight Deflectometer (FWD), Pavement Management Systems (PMS).

## Unit VI

(6 hrs.)

a) **Study of rigid pavement:** Philosophy of rigid pavement, comparison of rigid pavement over flexible pavement, types of rigid pavements, design of rigid pavement using IRC 58-2015 including design of joints, distresses in rigid pavement.

b) **Overlay types and their design as per IRC:** Types of overlays, design of overlay using IRC 81-1997.

### Term work:

1. Traffic counts using Manual Methods.
2. Design of a flexible pavement using IRC: 37-2012 using IITPAVE.
3. Design of rigid pavement using IRC: 58-2015.
4. Road deflections measurement using Benkelmen Beam method.
5. Design of an overlay using IRC: 81-1997.
6. Conduct of distress surveys on a flexible pavement or a rigid pavement and determining its condition index (PCI).
7. Study of any two softwares related to transportation engineering.
8. Study of format of household survey and recording sample measurements.
9. Parking survey and analysis.

### Reference Books:

1. Highway Engineering - Laurence I Hewes & Clarkson H Oglesby
2. Traffic Engineering and Transport Planning - L R Kadiyali, Khanna Publishers.
3. The Design and Performance of Road Pavements - David Croney, Paul Croney.
4. Understanding Traffic System - Michel A Taylor, William Young, Peter W Bonsall.
5. Principles of Urban Transport Systems Planning - B. G. Hutchinson.
6. Introduction to transport planning - M. J. Bruton.

7. Transportation Engineering An Introduction – C. Jotin Khisty, B. Kent Lall, Pearson Publication.
8. Transportation Engineering & Planning – C. S. Papacostas, P. D. Prevedouros, Pearson Publication.
9. Principles of Pavement Design - E.F. Yoder (John Wiley & Sons, Inc USA).
10. Fundamentals of Transportation Engineering - C. S. Papacostas.
11. Pavement analysis and Design – Huang Y H, Prentice Hall, Englewood Cliff, New Jersey.
12. Introduction to Transportation Engg. and Planning – Morlok E K, McGraw-Hill company.
13. Fundamentals of Traffic flow Theory – Drew, McGraw-Hill book Co.
14. A course in Traffic Planning and design-Saxena Subhash,Dhanpat Rai & sons,Delhi
15. Traffic analysis (New technologies new solutions)-Taylor M P ,Hargreen Pub.Co. New Delhi.

**Codes:**

1. IRC 37-2012
2. IRC 58-2015
3. IRC 81-1997
4. IRC 82-2015
5. IRC 115-2014

**Hand Books:**

Handbook of Road Technology \_Lay M. G.Gorden Breach Science Pub.Newyork.

**e-Resources:**

- 1) [www.nptel.iitm.ac.in/courses/iitkanpur](http://www.nptel.iitm.ac.in/courses/iitkanpur)
- 2) [www.cdeep.iitb.ac.in/nptel](http://www.cdeep.iitb.ac.in/nptel)

## **401 010      Elective IV (3):    Advanced Foundation Engineering**

### **Teaching Scheme**

**Lectures: 3 Hours/week**

**Practical: 2 Hours/week**

### **Examination Scheme**

**Theory Examination:**

**In-sem : 30 marks (1 Hr.)**

**End-sem:70 marks (2.5Hrs.)**

**Term work: 50 Mark**

### **Unit I**

**(6 Hrs.)**

IS code provision in respect of subsoil exploration for dams, canals, tunnels, off shore structure, air ports and bridges. IRC, provisions for exploration in respect of roads. Case studies of failures of foundation.

### **Unit II**

**(6 Hrs.)**

Design of pile based on cyclic load test. Study of provision made in different IS codes related to deep foundation, various types of pile. Design of Racer piles & piles subjected to lateral load. Testing and Design of piles subjected to tensile loads.

### **Unit III**

**(6 Hrs.)**

Design of under reamed pile foundation subjected to tensile loads. Design of sand drains and stone columns.

### **Unit IV**

**(6 Hrs.)**

Design of shallow foundations subjected to inclined loads. Design of Raft foundation on different types of soil. Design of combined and isolated footing based on field test including calculation of settlement. Introduction to software available for geotechnical foundation design.

### **Unit V**

**(6 Hrs.)**

Study of various provisions made as per IRC and as per IS in respect of design of well foundation. Case studies of failure of well foundation. Design of Rock fill coffer Dams.

### **Unit VI**

**(6 Hrs.)**

Stress distribution in the shaft, tunnels, underground conduits, classification, load on ditch conduits, positive and negative projecting conduits, and Imperfect ditch conduits.

**Term Work:****Term work will consist of****A) Any Four of following 6 assignments.**

- 1) Comparative study of provisions made for the extent of exploration in IS, IRC codes adapted by Indian railways, and PWD.
- 2) Detailed study of any two Geophysical methods of exploration.
- 3) Computations of Bearing capacity and Settlement of a Shallow Foundation involving inclined loads.
- 4) Design of Pile foundations subjected to inclined load and tensile load.
- 5) Design of Sand Drains.
- 6) Comparative study of provisions for well Foundation as per IS, IRC and code adapted by Indian railways.

**B) Computer Modeling:**

Design of any one type of Deep foundation using computer software.

**C) Site visit and Case study:**

- 1) One site visit to any important deep foundation and submission of report on the same giving details of design and construction.
- 2) Any one case study of failure of foundation from the published literature.

**Reference Books:**

1. Foundation Analysis and Design- Joseph E. Bowels, TATA Mc-Graw hill.
2. Design Aids in Soil Mechanics and Foundation Engineering-Shenbaga R Kaniraj, TATA Mc-Grawhill.
3. Foundation Design & Construction (4th Ed.)- M.J.Tamlinson, ELBS publication.
4. G. A. Leonards, Foundation Engineering, McGraw-Hill, 1962.
5. R.B. Peck, W.E. Hanson and T.H. Thornburn, Foundation Engineering, 2nd Edition, John Wiley and Sons, 1974.
6. "Principles of Foundation Engineering" by B.M. Das.
7. Theory and Practice of Pile Foundations Wei Dong Guo CRC Press.

**I.S .Codes:**

IS: 1892-1979 – "Code of Practice for Subsurface Investigation for Foundation".

IS: 2131-1981 (Reaffirmed 1997), "Method for Standard penetration Test for Soils".

IS: 6403-1981 – “Code of Practice for Determination of B.C. of Shallow Foundation”.

IS: 8009 (Part-1) 1976, “Code of Practice for Calculation of settlements of foundations”.

IS: 1904-1986, “Code of Practice for Design and Construction of Foundations in Soils, general Requirements”.

IS: 2911-1979, “Code of Practice for Design and Construction of Pile Foundation”.

**Handbooks:**

1. Fang , H.Y.,(1991),” Foundation Engineering Handbook”, Chapman & Hall, NY.
2. Teng .W.C.(1962), Foundation Design , Prentice Hall International.
3. Foundation Design Manual by Narayan V. Nayak, Dhanpat Rai & Sons.

## 401 0010 Elective IV (4): Coastal Engineering

### Teaching Scheme

Lectures: 3 Hours/week

Practical: 2 Hours/week

### Examination Scheme

Theory Examination:

In-sem: 30 marks (1 Hour)

End-sem: 70 marks (2.5.Hours)

Termwork : 50 marks

### Unit I

(6 Hrs.)

#### Basics of Ocean Waves:

Generation ,classification, Basic understanding of wave mechanics including wave propagation,wave theories,, wave diffraction , wave refraction, wave breaking. Waves of unusual character-currents, giant waves , tsunami etc.

### Unit II

(6 Hrs.)

#### Tides:

Tide producing forces- earth moon and earth sun system , dynamic theory of tides-; types of tides- tides and tidal current in shallow sea, storm surges, tides in rivers and estuaries ,tidal power.

### Unit III

(6 Hrs.)

#### Coastal Processes:

Coastal process- Erosion/accretion due to waves, bed forms, long shore transport (Littoral drift) estimate of wave induced sediment, budget. Tides, effect of Tides, stability of inlets. Effect of construction of coastal structures on stability of shoreline / beaches.

### Unit IV

(6 Hrs.)

#### Design of Marine Structures:

Design of Marine Structures: Seawalls, Revetments, Breakwater rubble mound, composite, floating and pneumatic types, and jetties. Offshore structures, Oil Production platform, sub marine pipelines. Model studies.

### Unit V

(6 Hrs.)

#### Design Technology:

Dredging Technology: Types of dredgers, design of disposal methods of dredged materials Environmental aspect of dredging , studies for feasibility of dumping ground for dredged material.

### Unit-VI

(6 Hrs.)

#### Coastal Management:

Pollution in Coastal zone, disposal of waste/dredged spoils, design criteria of coastal outfall inlets and system. Oil spills and contaminants, coastal zone management: activities in coastal zone, CRZ, Issues related to Integrated coastal zone management. Coastal regulation zone.

### Reference Books:

1. Brunn Per ,B. U. Naik, "Shore Protection Manual", NIO Goa.
2. Quinn A. D., "Port Planning", Mc Grow Hill Book Co. New York.
3. Richard Silvester, "Coastal Engineering", Vol-I-II, University of Western Australia.
4. Shore Protection Manual-U.S.Waterways Experiment Station Corps of Engineer.
5. Coastal Engineering Research Center, Vickburg and U.S.A.1984.Coastal Protection Manual 2002.
6. Harbour and Coastal Engineering", Vol. I&II, Ocean and Coastal Engineering Publication, NIOT, Chennai.

### Term work-

One assignment on each unit.

## 401 010 Elective IV: Open Elective : 5 (a): Plumbing Engineering

### Teaching Scheme:

Lectures: 3 hours/week

Practical: 2 hours/week

### Theory Examination Scheme:

In-sem : 30 marks (1 Hour)

End-sem :70 marks (2.5 Hours)

Term work: 50 Marks

### Unit I

(6Hrs.)

**Introduction to plumbing engineering** Definition- plumbing engineering/public health engineering, Indian plumbing industry, Roles of plumbing contractor, plumber, plumbing consultant, plumbing terminology, Principles of plumbing,

#### a) Introduction to codes and standards:

Introduction to UPC-I and ITM, Green plumbing code supplement-India (GPCS-I) and other codes applicable in plumbing, Approvals of authority having jurisdiction, General regulations, Testing and labeling, Alternative materials, workmanship and minimum standards, Prohibited fittings and practices, Local laws related to plumbing.

#### b) Architectural and structural coordination, plumbing shafts, Sunken toilet floors, Ledge walls.

### Unit II

(6 Hrs)

#### Water Supply, fixtures and fittings.

a) Water Supply: Types of water supply pipes Fittings and joints, Galvanized iron, Copper, Stainless steel, HDPE, MDPE, Rigid PVC, CPVC, PPR, Composite pipes, (PE-AL-PE), PEX, Joints, Jointing methods and materials, Tools etc. Water hammering, Pipe protection, Velocity, pressure, temperature limitations, Water Supply Fixture Unit (WSFU), Sizing, testing, Valves and regulators, Backflow prevention, Commissioning, Water tanks.

b) Plumbing fixtures, Water conserving fixtures, Rating system for water efficient products, (WEP-I), Water closets, Bidets, Urinals, Flushing devices, Lavatory and bath units, Kitchen sinks, Water coolers, Purifiers, Drinking water fountain, Cloth washers, Mop sinks, Dish washers, Receptors Overflows, Strainers, Standard heights. Prohibited fixtures, Floor slopes, Minimum spacing.

### **Unit III**

**(6Hrs.)**

#### **Sanitary system and Storm water Drainage:**

**a) Sanitary system:** Fixtures, Appliances and appurtenance, Classification of fixtures, Soil and waste and grey water, Soil fixtures, Bathroom fixtures, Accessories, Indirect waste connections, Food handling establishments, Fixtures below invert level.

#### **b) Building Drains:**

Introduction, Four systems of plumbing, One pipe and two pipe system, Air admittance valves and solvents, Comparison of systems, Vent pipe, Symphonic action, Antisiphon and vent pipes, Loop, Circuits, Types of building drainage pipes, Fittings and jointing methods, Clean outs, Drainage fixture units (DFU), Sizing, Testing, Case study

### **Unit IV Traps and Interceptors**

**(6Hrs.)**

Traps-Purpose, Fixture traps and floor traps, Prohibited traps, Trap arm, Developed length, Trap seal, Trap seal protection, Venting of traps, Trap primers, Building traps, Clarifiers, Grease interceptors, Sizing, oil and sand interceptors.

#### **b) Vents:**

Vent requirement, Parts of vent system. Parts of vent system, Materials, Sizing, Vent connections, Flood rim level, Island sink venting, Venting of interceptors, Water curtain and hydraulic jump, Termination of vent stacks, Stack venting, Yoke vent, Wet venting.

### **Unit V**

**(6Hrs.)**

#### **a) Building Sewers:**

DFU, Change in direction of flow, Hydraulic jump, Sudsing stack, Cleanouts, Pipe grading, pipes and fittings suitable for building sewers, RCC, PVC, Nu-Drain, Stoneware., Sizing, testing, Types of traps, Gully, Chambers and manholes, Materials, Venting, Sizing, Testing, Sumps, Pumps, Sewage disposal, Septic tanks.

#### **b) Plumbing in high rise buildings:**

Definition of high rise building, Multiple storage tanks, Plumbing shafts, Break pressure tanks, Water supply, Hydro pneumatic system, Pressure reducing valves, Building drainage system, Rain water system, Sizing, Testing, Case study, Introduction to centralized hot water supply, Principles of design.



## Unit VI

(6 Hrs)

### Design Parameters & Case Study

Introduction, Plumbing Drawings & Layouts, Water Supply Design Consideration, Sewer Network design consideration, Storm water design consideration as per CPHEEO manuals, Case study on each.

### Term work

**Term work will consist of 8 assignments with necessary plans /sketches.**

1. Introduction of available codes in plumbing
2. Introduction of associations in plumbing in India and outside India
3. Detailed hydraulic design for High rise structure OR G+1 Bungalow by using software.
4. Compilation of rules and regulations of local governing bodies.
5. Roles of plumbing contractor and plumbing consultants.
6. Report on Plumbing fixtures and fittings and explain any ten.
7. Report on materials for water supply and drainage.
8. Report on necessity of traps, intercepts and vents

### Books:

1. "Plumbing Engineering" by Deolalikar.
2. "Plumbing, Sanitation and Domestic Engineering" Volume – 1 to 4 by G. S. Williams, Mc Graw Hill.
3. "Plumbing, Sanitation and Domestic Engineering, Data Sheets & Wall Charts" by G. S. Williams, Mc Graw Hill
4. "Plumbing Engineering, Theory and Practice" by Subhsh Patil. SEEMA Publishers Mumbai
5. "National Plumbing Codes Handbook", by R. Dodge Woodson.
6. "Central Public Health and Environmental Engineering Organisation Manual (CPHEEO)".

### Codes:

1. Uniform Plumbing Code- India (UPC-I), 2008
2. Illustrated Training Manual (ITM), 2008.

## **401 010 Elective IV: Open Elective: 5 (b): Green Building Technology**

### **Teaching Scheme:**

**Lectures: 3 Hours/week**

**Practical: 2 Hours/week**

### **Examination Scheme:**

**Theory Examination:**

**In-sem : 30 Marks (1 Hour)**

**End-sem:70 Marks (2.5 Hours)**

**Term work: 50 Marks**

### **Unit I:**

**(6 Hrs.)**

Materials and Its Applicability, Indoor Environmental Quality, Reuse and Recycle of Construction Waste.

- A) Eco Friendly/ Green Building Materials: To understand Environmental impact of building materials. Eco Friendly building materials, their composition, availability, production, physical properties etc. Application of the Eco Friendly/ Green Building materials for different components of the buildings at different level, both internally and externally.
- B) Indoor environmental quality, Low VOC materials: Adhesives - Sealants, Paints- Coatings etc.
- C) Construction Waste as a Resource- Resource Economics, Disposable Materials, Recovery, Recycling, Collection, Processing, Governmental Role in Waste Management, Potential for Reuse.

### **Unit II**

**(6 Hrs.)**

Site / Building Planning

- A) Sustainable Site planning: wind / sun path, water management , material use, landscape, topography.
- B) Climate Responsive Architecture: orientation, solar- wind, Building envelope.
- C) Thermal comfort indices. Heat flow through building materials. Thermal properties of common building materials available in India. Thermal performance of building envelope. Air movement and buildings. Ventilation and buildings. Wind an Stack effect. Mechanical ventilation. HVAC System, Day lighting. Passive and sustainable architecture. Passive and active systems.

### **Unit III**

**(6 Hrs.)**

Embodied Energy, Life Cycle Assessment, Environmental Impact Assessment, Energy Audit and Energy Management.

- A) Embodied energy of various construction materials. Introduction to the Concept: “Life Cycle assessment of materials”.
- B) EIA : Introduction to EIA., Process of EIA and its application through a case study., EIA as a strategic tool for sustainable development.
- C) Energy Management.

#### **Unit IV**

**(6 Hrs.)**

Appropriate Technologies / Approaches for:

- A) Water conservation / efficiency.
- B) Sanitation (Grey water, black water management, SWM)
- C) Treatments.
- D) Biogas.
- E) Composting.
- F) Solar energy and its applicability through panels, photovoltaic cells etc.
- G) Use of “LED, CFL, Fresnel Lens” etc.
- H) Wind energy and its use.
- I) Orientation aspects in site planning to achieve maximum daylight and natural ventilation.

#### **UNIT V:**

**(6 Hrs.)**

- A) Clean Development Mechanism.
- B) Kyoto Protocol.
- C) Energy Conservation Building Code.

#### **UNIT VI**

**(6 Hrs.)**

Rating Systems: - Leadership in Energy and Environmental Design (LEED), Green Globes, National Association for Home Builders (NAHB) – For Homes, Building Research Establishment Environmental Assessment Method (BREEAM), Green Star by Green Building Council Australia (GBCA), LEED India, Comprehensive Assessment System for Built Environment Efficiency (CASBEE), Estimada -Abu Dhabi Urban Planning Council (UPC) etc.

#### **Term Work:**

**Any Eight of the following:**

- A) To study: Innovative Materials Developed by CBRI, SERC.
- B) To study: Environmental Audit of any existing building and prepare a report.
- C) To study, analyze present scenario of organic waste collection and management of any of the premise; preferably hotels.

- D) To compare the benefits under different rating systems.
- E) To prepare detailed plan for a hypothetical site indicating utility of solar path, wind direction, rainfall intensity etc. to make it sustainable.
- F) To prepare a report on carbon credit.
- G) To prepare a report on energy efficient buildings in India.
- H) To study sustainable planning aspects for urban housing.
- I) Study of Design of On Site Sanitation Systems for Indian conditions developed by Appasaheb Patwardhan Safai V Paryavaran Tantraniketan, Dehugaon .
- J) To study the benefits given by Municipal Corporations to Green Buildings.

### **Reference Books and Additional Reading material:**

1. Manual of Tropical housing and climate by Koenisberger.
2. Climate responsive architecture by Arvind Krishnan.
3. Manual of solar passive architecture - by Nayak J.K. R. Hazra J. Prajapati.
4. Energy Efficient Buildings in India by Milli Mujumdar.
5. Green Building Materials by Ross Spiegel and Dru Meadows.
6. Publications from - CBRI – Roorkee, - IDC – Mumbai, NID – Ahmedabad.
7. Solar Energy in Architecture and Urban Planning by Herzog Thomas.
8. Solar Heating, Design Process by Kreider Jan F.
9. Energy - Manual for college teachers (CEE publications).
10. Renewable Energy & Environment - A policy analysis for India (CEE publications).
11. Sustainable Building Design Manual-Volume I and II –TERI Publication.
12. Mechanical and Electrical Systems in Construction and Architecture-by Frank R Dagostino.

### **Principles of Air conditioning-By V. Paul Lang:**

1. Heating, Cooling and lighting design methods for architecture. By Lechor Worbert.
2. LEED Manual.
3. Green Globes Manual.
4. Florida Green Building Coalition Manual.
5. The green building process.
6. Green building codes and standards.
7. International Green Construction Code.
8. ASHRAE 189P.
9. ANSI/GG 01, TERI, BREEAM etc.

## 401 010 Elective IV: Open Elective: 5 (c): Ferrocement Technology

### Teaching Scheme:

Lectures: 3 hours/week

Practical: 2 hours/week

### Examination Scheme:

Theory Examination:

In-sem : 30 marks (1 Hour)

End-sem: 70 marks (2.5 Hours)

Term work: 50 Mark

### Unit 1

(6 Hrs.)

What is Ferrocement?

- a) Definition, Basic concept like bond increase. Comparison with concretes like RCC, Prestressed, Asbestos cement, Fiber reinforced, Polymer concretes. Composition of ferrocement. Special types of ferrocement. Ferrocement as substitute for conventional building materials. Typical characteristics and their applications.
- b) Raw materials, skills, tools and plants. Ferrocement as material of construction. Forming a ferrocement structure. Properties and specifications of raw materials. Proportioning of cement mortar. Job requirements of required skills. Tools and plants.

### Unit 2

(6 Hrs.)

Mechanical properties and construction methods:

- a) Mechanical properties and typical features affecting design. Properties under static and dynamic loading. Shrinkage and creep. Testing of ferrocement.
- b) Methods of constructing ferrocement structures. Standardizing method of construction. Planning the work. Fabricating skeleton, tying meshes and mortaring. Curing. Maintenance. Protective surface treatments. Damage to ferrocement structures.

### Unit 3

(6 Hrs.)

Strength through shape and design:

- a) Strength through shape. Design of structure based on form and shape. Forms in nature, various structural forms and their behavior. Typical strengths of different materials. Comparative study of various forms.
- b) Design of ferrocement structures. Design, analysis and optimization. Special design considerations for ferrocement. Typical features of ferrocement affecting design. Conventional design methods like working stress, load factor, applied to ferrocement. Design based on equivalent area method for compression, tension and flexural members. Specific surface method and crack control method, Design of structures subjected to membrane stresses. Design of

shaped structures in ferrocement like stiffened plates, arch faced walls, stiffened cavity walls and hollow floors and beams, Design of forms like 'T' 'U' 'T' '+' 'L'

#### **Unit 4**

**(6 Hrs.)**

Cost analysis and ferrocement in Building construction.

a) Cost analysis : Factors governing cost analysis. Special considerations for ferrocement structures. Cost comparison with conventional construction. Specifications for ferrocement structures. Quantity analysis of material and labour for ferrocement items. Cost and value of ferrocement construction.

b) Ferrocement in building construction. Ferrocement in foundations, walls, floors roofs. Ferrocement single wall construction. Design and construction of houses with cavity walls, hollow floors and hollow beams. Staircases and other building accessories. Earthquake resisting structures. Special characteristics of ferrocement to resist shock loading design and construction of quake proof structures.

#### **Unit 5**

**(6 Hrs.)**

Hydraulic and soil retaining structures in ferrocement :

a) Hydraulic structures. Why ferrocement? Water retaining structures, Storage tanks of various types. Structures across streams. Ferrocement in layered form used for lining, water proofing and surface coating.

b) Soil retaining structures. Types of retaining walls and their comparison with ferrocement arch faced wall. Design and method of fabrication and casting. Ferrocement counterfort retaining wall. Ferrocement containers for storing granular materials.

#### **Unit 6**

**(6 Hrs.)**

**Space structures and precast products:**

a) Ferrocement large size special purpose structures. Space structures like shells, pyramids, domes corrugated catenaries.

b) Precast ferrocement products : Why ferrocement for precasting? Methods of precasting. Design of precast elements. Ferrocement precast walling and flooring panels. Joints in precast ferrocement elements.

#### **Term Work :**

Minimum 02 site visits with detailed reports and one assignment based on each unit ( Journal consisting of total 6 assignments + 2 visit reports).

**Books Recommended:**

- 1) Ferrocement Technology- A Construction Manual. -- Dr. B. N. Divekar Published by the Author.
- 2) Ferrocement --- : B. R. Paul and R. P. Pama. Published by International Ferrocement Information Centre. A.I.T. Bangkok, Thailand.
- 3) Ferrocement and laminated cementitious composites --: A.E. Naaman. Publisher : Technopress, Ann Arbor, Michigan, USA.
- 4) Ferrocement - Materials and applications; Publication SP 61, A C I Detroit. USA
- 5) State of the art report and guide for design, Construction and repairs of Ferrocement; ACI Committee Report. No. ACI 549R-88 and ACI 549.1R.88. Published by American Concrete Institute, Detroit, USA.
- 6) Chapter 1 titled 'Ferrocement' by S. P. Shah and P. N. Balaguru in book 'Concrete Technology and Design Vol. II, Editor; R. N. Swamy.
- 7) Proceedings of International Symposiums on 'Ferrocement and thin reinforced composites – Ferro 1 to Ferro 10. Available with International Ferrocement Information Centre, A I T Bangkok, Thailand.
- 8) Ferrocement Conference Proceedings of Ferrocement Society, India--FS 2011, F.S.2013, F. S. 2015.



## 401 010 Elective IV: Open Elective: 5 (d): Sub Sea Engineering

### Teaching Scheme

Lectures: 3 hours/week

Practical 2 hours/week

### Examination Scheme

Theory Examination

In-sem: 30 marks (1 Hour)

End-sem: 70 marks (2.5.Hours)

Termwork: 50 Marks.

### Unit1

(6 Hrs.)

**Introduction to oil and gas industry:** general view of oil and gas industry, technological challenges and future developments. Overview of deep water developments: introduction, deep water areas and potential, challenges, route for development Metocean and environmental conditions: Overview of the determination of Metocean conditions (meteorological and oceanographic) and the influence of wave, wind, tide and current on marine operations. Introduction to marine ecology and its impact on marine operations.

### Unit 2

(6 Hrs.)

**Introduction to subsea infrastructure development:** Summarize the current state of the art and highlights the design challenges. Outlines the way in which water depth influences the architecture and technology of Oil and Gas infrastructure.

**Flow assurance:** overview of flow assurance and the fundamentals of flow management for subsea production systems, Introduction to flow assurance issues like paraffin deposition; hydrate formation and blockage; Asphaltene precipitation; emulsions; experimental methods, flow assurance assessment methods; prevention, mitigation and remediation tools for flow assurance issues; thermal management and insulation materials.

### Unit 3

(6 Hrs.)

**Subsea installation and intervention:** Overview of the installation of subsea plant, risers and pipelines and the main intervention methods including AUVs, ROVs and divers.

**Subsea operations and control:** An overview of the principle methods of subsea control including electrical, acoustic and hydraulic systems.

**Subsea processing and artificial lift:** introduction the analytical and numerical models used to design subsea processing systems for sustained recovery of hydrocarbons.



#### Unit 4

(6 Hrs.)

**Reliability and integrity management:** Introduction to Risk Assessment, FMECA and HAZOPS, Monitoring, Intervention and Inspection Methods, Data Management Construction management of oil field, future challenges.

#### Unit 5

(6 Hrs.)

**Subsea field equipment, structures and architectures:** scale of operations, environmental factors, A description of each of the pieces of the subsea infrastructure, their use and interconnection including subsea trees, flow lines, umbilicals, risers, moorings and pipelines Materials and corrosion. Types of corrosion found in the oilfield with emphasis on the effects of acid gases (CO<sub>2</sub> and H<sub>2</sub>S).

#### Unit 6

(6 Hrs.)

**Pipelines and design:** Introduction to pipeline engineering, the main pipeline design challenge in deep water. Analysis and design methods of pipelines that address stress analysis, buckling and collapse of deep water pipelines. Limit state based strength design methods. Geotechnical aspects of pipeline design and its installation.

**Deepwater risers:** different design options available for deep water risers, and defines the key design drivers for each. General principles of stress analysis: An introduction to the principles of stress analysis and the principles of reliability based design, finite element analysis.

**Termwork:**--Shall consist of one assignment per unit.

#### References:

1. A Primer of Offshore Operations by Petex
2. Subsea Engineering Handbook Hardcover by Yong Bai (Editor), Qiang Bai (Editor)
- C. Norsok standard Common requirements Subsea structures and piping system U-cr-001 Rev. 1, January 1995.
- D. Norsok codes, DNV codes : Design specifications for subsea system.

## **401 010 Elective IV : Open Elective : 5 (e): (Geoinformatics)**

### **Teaching Scheme:**

**Lectures: 3 Hrs/week**

### **Examination Scheme:**

**Paper In-sem. 30 Marks (1 Hrs),**

**Paper End-sem : 70 Marks (2.5 Hrs.)**

### **Unit I**

**(6 Hrs.)**

#### **Introduction to Remote Sensing GIS and SBPS:**

Electro-magnetic radiations (EMR) - atmospheric scattering, Raleigh scattering, Mie scattering, non-selective scattering -atmospheric absorption - atmospheric windows, refraction - interaction of EMR earth's surface - reflection - transmission - spectral signature - Reflectance characteristics of Earth's cover type: Vegetation, water, soil

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements. Introduction to SBPS, Segments and errors in GPS.

### **Unit II**

**(6 Hrs.)**

**THERMAL REMOTE SENSING:** Thermal radiation principles – Thermal interaction sensors and characters – thermal image characters – image degradation sources & correction – interpretation of thermal images – Application and Case studies.

**MICROWAVE REMOTE SENSING:** Introduction-Plane waves-Interference, Radar remote sensing - Radar basics- Antenna Systems -Real aperture radar - Radar frequency bands - SLAR Imaging Geometry, Resolution Concepts - Geometric Distortions, SAR – Concepts - Doppler principle & Processing. RADAR Interaction with earth surface- RADAR equation.

### **Unit III Unit II**

**(6 Hrs.)**

#### **DIGITAL IMAGE PROCESSING :**

Fundamentals of Image Processing, sensors model and pre processing, image enhancement, image classification, object recognition.

## **Unit IV**

**(6 Hrs.)**

### **OPEN SOURCE GIS:**

**DESKTOP GIS WITH OPEN SOURCE GIS :** View Graphics – Data exchanges- portability and interoperability – Raster handling and Image analysis – vector data management – Raster and vector analysis - 2D/3D vectors with topology, 3D Voxel, 2D Raster.

**OPEN SOFTWARE AND WEB MAPPING :** Open Source Software : GRASS, QGIS, OSSIM, PostgresSQL and (R) Environment – WEB Mapping Architecture and components – WEB mapping servers- Thin clients in WEB mapping - WMS,WFS, WCS,WPS and other web services- Open Server standards.

## **Unit V**

**(6 Hrs.)**

### **MAP PROJECTION:**

Concepts of sphere, ellipsoid and geoid - latitudes, longitudes and graticules –map projections– shape, distance, area and direction properties - role of aspect, development surface, secant and light source / view points – perspective and mathematical projections – Indian maps and projections – Map co-ordinate systems – UTM and UPS references – common projections and selections– projections for hemispheres and the world maps , Map projection for cadastral maps.

## **Unit VI**

**(6 Hrs.)**

### **FUNDAMENTALS and GEOMETRIC GEODESY:**

Definitions- Classifications, Problem of Geodesy and purpose of Geodesy Historical development and Organization of Geodesy. Reference Surfaces and their relationship. Applications, Engineering, Lunar, Planetary and interferometric Synthetic aperture radar Geodesy – Local and International Spheroid.

Geometry of ellipsoid, fundamental mathematical relationship of ellipsoid, Geodetic, Geocentric and Reduced latitudes and their relationship. Ellipsoidal Co-ordinates in terms of Reduced, Geodetic and geocentric latitude. Radius of curvature in the meridian & prime vertical and their relationship. Mean Radius of curvature in any azimuth, Length of the meridian arcs and arcs of parallel and Area of trapezium on the ellipsoid. Curves on the ellipsoid, properties of Geodesic.

**Reference Books:**

1. Wolfgang Torge, Geodesy, Walter De Gruyter Inc., Berlin, 2001
2. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York, 2002.
3. Neteler M, Helena M (2008) \_Open source GIS: A GRASS GIS approach', 3rd edn, Springer, New York
4. Kang-Tsung Chang, Introduction to Geographic Information Systems, Mc-Graw Hill Publishing, 2nd Edition, 2011.
5. John, R. Jensen, Introductory Digital Image Processing, Prentice Hall, New Jersey, 2005 3rd edition
6. R.W. Anson and F.J. Ormeling, Basic Cartography for students and Technicians. Vol.I, II and III, Elsevier Applied Science Publishers, 3rd Edition, 2004.

## 401006 Project work

### Teaching Scheme:

**Tutorial: 6 Hrs/week**

### Examination Scheme:

**TW : 50 Marks.**

**Oral : 100 Marks.**

Project Work will be evaluated for an individual student based on the presentation of the work done in a year( I Sem + II Sem) and submission of the report .The student may work in a group during project work, if any.

The project work shall consist of any one of the following nature in Civil Engineering related subjects.

1. Experimental investigation.
2. Software development.
3. Benefit : Cost economic analysis.
4. Case study with own design.
5. Working model design and fabrication.
6. Case study with development of methodology using soft computing tools.

The details of report writing and preparation of report will be similar to that of as mentioned in syllabus of Project Phase I in first semester.

**Evaluation of Project work in final exam.** Will be done by the pair of internal guide having minimum 3 years approved experience as teacher and external guide.

It is recommended to promote the students to present a paper based on project work in appropriate conference / journal.