

**COURSE SCHEME & SYLLABUS FOR M.E. (CIVIL INFRASTRUCTURE ENGINEERING) (w.e.f 2016)**

**SEMESTER – I**

<b>SR. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PIN101/PIN 104	DESIGN OF HYDRAULIC STRUCTURES	3	2	0	4.0
2.	PIN102	INFRASTRUCTURE PLANNING AND MANAGEMENT	2	0	0	2.0
3.	PIN103	REMOTE SENSING AND GIS	3	0	2	4.0
4.	PCL105	STATISTICAL METHODS AND ALGORITHM	3	0	2	4.0
5.	PCE321/ PCE105	ADVANCED FOUNDATION ENGINEERING	3	2	0	4.0
<b>TOTAL</b>			<b>14</b>	<b>4</b>	<b>4</b>	<b>18.0</b>

**SEMESTER – II**

<b>SR. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PIN201	SITE EXPLORATION AND FIELD TESTING	2	0	3	3.5
2.	PIN202	TRANSPORTATION PLANNING AND ECONOMICS	3	2	0	4.0
3.	PES225	ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT	3	1	0	3.5
4.		ELECTIVE – I	3	2		4.0
5.		ELECTIVE – II	3	2	0	4.0
6.		ELECTIVE - III	3	2	0	4.0
7.	PIN291*	INDUSTRIAL TRAINING (SIX WEEKS IN SUMMER VACATIONS)	-	-	-	3.5
<b>TOTAL</b>			<b>17</b>	<b>9</b>	<b>3</b>	<b>26.5</b>

\*: in summer vacations

**SEMESTER – III**

<b>SR. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PCE301	MASS TRANSPORTATION SYSTEMS	3	2	0	4.0
2.		ELECTIVE – IV	3	2	0	4.0
3.	PIN391	SEMINAR	-	-	-	4.0
4.	PIN392	MINOR DESIGN PROJECT	-	-	-	4.0
<b>TOTAL</b>			<b>6</b>	<b>4</b>		<b>16.0</b>

**SEMESTER – IV**

<b>SR. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PIN491	DISSERTATION	-	-	-	16.0
<b>TOTAL</b>						<b>16.0</b>

**TOTAL NUMBER OF CREDITS: 76.5****ELECTIVES – I**

<b>S. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PCE101	ADVANCED STRUCTURAL ANALYSIS	3	2	0	4.0
2.	PCE323	INDUSTRIAL STRUCTURES	3	0	2	4.0
3.	PIN112	GEOTECHNIQUES	3	2	0	4.0
4.	PIN113	DESIGN OF WATER SUPPLY AND SEWERAGE SYSTEMS	3	2	0	4.0
5.	PIN114	SMART MATERIALS AND STRUCTURES	3	2	0	4.0

**ELECTIVES – II**

<b>S. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PIN211	HYDROPOWER ENGINEERING	3	2	0	4.0
2.	PCE212	TALL STRUCTURES	3	0	2	4.0
3.	PCE301	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	3	2	0	4.0
4.	PIN213	TRAFFIC ENGINEERING	3	2	0	4.0
5.	PCE211	ADVANCED BRIDGE DESIGN	3	0	2	4.0

**ELECTIVES – III**

<b>S. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PIN221	ADVANCED HYDROLOGY	3	2	0	4.0
2.	PIN222	GROUND IMPROVEMENT	3	2	0	4.0
3.	PIN223	DESIGN OF PAVEMENTS	2	0	4	4.0
4.	PIN224	INTELLIGENT TRANSPORT SYSTEMS	3	2	0	4.0

**ELECTIVES – IV**

<b>S. NO.</b>	<b>COURSE NO.</b>	<b>TITLE</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CR</b>
1.	PIN311	MECHANICS OF SEDIMENT TRANSPORT	3	2	0	4.0
2.	PIN312	RETAINING STRUCTURES	3	0	2	4.0
3.	PIN313	REHABILITATION OF STRUCTURES	3	2	0	4.0
4.	PIN314	ADVANCED RAILWAY AND AIRPORT ENGINEERING	3	2	0	4.0

5.	PIN315	DISASTER MITIGATION AND MANAGEMENT	3	2	0	4.0
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## PIN101/PIN104: DESIGN OF HYDRAULIC STRUCTURES

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the different types of dams and their working principles.

**Introduction:** Types, classification, factors governing the selection of a dam site

**Gravity Dams:** Forces acting on gravity dam, Design, Modes of failure and criteria for structural stability, principal and shear stress, methods of analysis, elementary profile of a gravity dam, high and low gravity dam, Joints in gravity dam, Galleries, foundation treatment

**Earth dam:** Classification, Method of construction, Causes of failure, Design criteria, seepage line and its location, Design of Filters, Seepage control, Stability of earth dams.

**Arch dams:** Types, forces acting on arch dam, design of arch dam

**Buttress dams:** Types, forces acting on buttress dam, design of buttress dam

**Spillways:** Location, types, design consideration, energy dissipation below spillways, design of stilling basin, spillway crest gates

**Assignment/Project:** To design the gravity dams based upon site specific data.

### **Course Learning Outcomes (CLO):**

After the completion of this course the students would be able to:

1. Design the various types of dams.
2. Analysis the stability of the existing dams for the loading conditions.
3. Design the appropriate types of spillways.

### **Recommended Books:**

1. Garg, S. K., *Irrigation Engineering and Hydraulic structures*, Khanna Publishers, New Delhi (2010).
2. Varshney, R. S., *Concrete Dams*, Oxford and IBH Publishing Company, New Delhi.(1982)
3. Novak, Pavel, Moffat, A I B, and Nalluri, C., *Hydraulic structures*, Taylor & Francis, (2001).

### **Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

## PCE321/ PCE105 : ADVANCED FOUNDATION ENGINEERING

L	T	P	Cr
3	2	0	4.0

**Course Objectives:** To understand the concepts of bearing capacity of soil so as to have deeper understanding in the design of foundations

**Shallow foundations:** Terzaghi's bearing capacity equation, General bearing capacity equation, Meyerhof's Vesic theory, Effect of water table, Special footing problems, I.S. Codes, Footing pressure for settlement on sand, Soil pressure at a depth, Boussineq's and Westergaard's methods, Computation of settlements, Inclined and Eccentric Loads.

**Pile foundations:** Timber, Concrete, Steel piles, Estimating pile capacity by dynamic formula, by wave equation and by static methods, Point bearing piles, Pile load tests, Negative skin friction, Modulus of sub-grade reaction for laterally loaded piles, Lateral resistance, Pile group considerations, Efficiency, Stresses on underlying strata, Settlement of pile groups, Pile caps, Batter piles, Approximate and Exact analysis of pile groups, I.S. Codes.

**Well Foundations:** Types (open end, closed or box, Pneumatic, Drilled), Shapes, Bearing capacity and settlements, Determination of grip length by dimensional analysis, Stability of well foundations by IRC Method, Construction, Tilts & shifts.

**Machine Foundations:** Types, Analysis and design by Barkans method, Determination of coefficient of uniform elastic compression, and Design of a machine foundation, I.S. Method of design.

**Introduction to Geotechnical Earthquake Engineering:** Ground Shaking, Liquefaction, Evaluation, Mechanism, Effects of liquefaction.

**Sheet pile Structures:** Types, Cantilever, Anchored sheet, Design by free earth & fixed earth method, Anchored braced sheeting, Cofferdams, Stability of cellular cofferdam, Instability due to heave of bottom.

**Assignment / Project:** Design of Pile and Well foundations based upon real project site specific data.

### Course Learning Outcomes (CLO):

After the completion of this course the students would be able to:

1. Understand the concept of evaluation of bearing capacity for shallow foundations
  2. Evaluate the load carrying capacity of pile and well foundations
  3. Perform geotechnical analysis of machine foundations
  4. Understand the concept of liquefaction of soils
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**Recommended Books:**

1. Bowles, Joseph E. , *Foundation Analysis and Design*, Tata McGraw Hill (2001).
2. Coduto, Donald P., *Foundation Design: Principles and Practice*, Prentice Hall (2001).
3. Dass, B. M. , *Principles of Foundation Engineering*, Thomson Learning (2006).
4. Kramer, Steven L., *Geotechnical Earthquake Engineering*, Pearson Education (2003).
5. Murthy, V.N.S., *Advanced Foundation Engineering*, C.B.S. Publishers (2007).

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

## **PIN102: INFRASTRUCTURE PLANNING AND MANAGEMENT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2.0</b>

**Course Objectives:** To understand various concepts of infrastructure planning and management.

**An overview of Basic Concepts Related to Infrastructure:** Introduction to Infrastructure, an overview of the Power Sector in India., an Overview of the Water Supply and Sanitation Sector in India., an overview of the Road, Rail, Air and Port Transportation Sectors in India. , an overview of the Telecommunications Sector in India. ,an overview of the Urban Infrastructure in India, an overview of the Rural Infrastructure in India, an Introduction to Special Economic Zones, Organizations and Players in the field of Infrastructure, The Stages of an Infrastructure Project Lifecycle., an overview of Infrastructure Project Finance

**Private Involvement in Infrastructure:** A Historical Overview of Infrastructure Privatization. The Benefits of Infrastructure Privatization, Problems with Infrastructure Privatization, Challenges in Privatization of Water Supply: A Case Study, Challenges in Privatization of Power: Case Study, Privatization of Infrastructure in India: Case Study, Privatization of Road Transportation Infrastructure in India.

**Challenges to Successful Infrastructure Planning and Implementation:** Mapping and Facing the Landscape of Risks in Infrastructure Projects, Economic and Demand Risks: The Case study for Political Risks, Socio-Environmental Risks, Cultural Risks in International Infrastructure Projects, Legal and Contractual Issues in Infrastructure, Challenges in Construction and Maintenance of Infrastructure.

**Strategies for Successful Infrastructure Project Implementation:** Risk Management Framework for Infrastructure Projects, Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Introduction to Fair Process and Negotiation, Negotiating with multiple Stakeholders on Infrastructure Projects, Sustainable Development of Infrastructure, Information Technology and Systems for Successful Infrastructure Management, Innovative Design and Maintenance of Infrastructure Facilities, Infrastructure Modeling and Life Cycle Analysis Techniques, Capacity Building and Improving the Governments Role in Infrastructure Implementation, An Integrated Framework for Successful Infrastructure Planning and Management - Infrastructure Management Systems and Future Directions.

**Assignment/ Project:** Case study of some successful & sustainable infrastructure projects.

### **Course Learning Outcomes (CLO):**

After the completion of this course the students would be able to

1. Understand the role of private sector in infrastructure growth.
  2. Understand the strategies for successful Infrastructure Project implementation.
  3. Infrastructure modelling and Life Cycle Analysis Techniques.
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**Recommended Books:**

1. Grigg, Neil, *Infrastructure engineering and management*, Wiley, (1988).
2. Haas, Hudson, Zaniewski, *Modern Pavement Management*, Krieger, Malabar, (1994).
3. Hudson, Haas, Uddin, *Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation*, McGraw Hill, (1997).
4. Munnell, Alicia, Editor, *Is There a Shortfall in Public Capital Investment? Proceedings of a Conference Held in June* (1990).
5. *World Development Report 1994: Infrastructure for Development* (1994).
6. Zimmerman, K. and F. Botelho, "Pavement Management Trends in the United States," *1<sup>st</sup> European Pavement Management Systems Conference*, Budapest, September (2000).

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## **PIN103: REMOTE SENSING AND GIS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>0</b>	<b>2</b>	<b>4.0</b>

**Course Objectives:** To analyze the remote-sensed data for solving geospatial problems.

**Principles and Fundamentals of Remote Sensing: Sources of Energy** – Active and Passive radiation – Electromagnetic Radiation – Nomenclature, Reflectance, Transmission and Absorption, Thermal Emission – Plank’s formula, Stefan – Boltzman Law, Wein’s Displacement Law; Emissivity – Kirchoff’s Law, Characteristics of Solar Radiant Energy.

**Sensors and Platforms:** Types of sensors, Multispectral, hyper spectral, thermal, orbital characteristics, working principles and instrumentation. Storage and Retrieval of data - IRS and ERS satellite systems – Introduction, Stages of development, Sensory Characteristics, Orbit and Coverage’s, various types of data product and its uses.

**Data Processing:** Initial data statistics. Pre-processing – Atmospheric, Radiometric and Geometric corrections.

**Data analysis:** Image Interpretation Elements, Keys and Aids. Basic Instrumentation - Visual analysis of data in application of remote sensing to various engineering fields.

**Principles of Geographical Information Systems (GIS):** Geographic information and spatial data types, Hardware and software; GIS; Steps of spatial data handling, database management systems, Spatial referencing.

**Data:** Quality, measures of location errors on maps, Satellite-based positioning, Spatial data input, data preparation, Point data transformation.

**Analytical GIS capabilities:** Retrieval and classification; overlay functions, neighbourhood operations; network analysis; error propagation, Data visualization.

**Assignment / Project:** Analyses of the remote sensed data for the project.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. To design the various processes involved in remote sensing.
2. To processes the raw data and prepare the final product after necessary corrections.
3. To interpret the remotely sensed data.
4. To learn the use geospatial data for the benefit of the end users.

### **Recommended Books:**

1. *Lillisand, T.M. & Kiefer R.W, Remote Sensing and Image Interpretation, John Wiley and Sons, (2004).*
  2. *Campbell, J.B., Introduction to Remote Sensing, Taylor and Francis, (2002).*
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3. Nag. P. & Kudrat, M., *Digital Remote Sensing*, Concept Publication Company, (1998).
4. Jhanwar, M.L. and Chouhan, T.S., *Remote Sensing and Photogrammetry – Principles and Applications*, Vigyan Prakashan, Jodhpur, (1998).

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/tutorial)	25

## PCL105: STATISTICAL METHODS AND ALGORITHMS

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>0</b>	<b>2</b>	<b>4.0</b>

**Introduction:** Nature and objectives of research, Study and formulation of research problem. Scope and formulation of hypothesis. Preparation and presentation of research proposal using statistical package.

**Review of Probability:** Appraisal of axiomatic approach of probability, Conditional probability, Baye's rule, Conditional distributions, and conditional expectations.

**Markov chains:** Basics of markov chains, Finite state space, Markov chains, Transition and stationary markov chains. Continuous time markov process: continuous time branching processes, Kolmogorov, Forward and backward equations, Pure birth, Pure death, Birth and death process.

**Analysis of variance:** One Way Classification: ANOVA for fixed effect model, ANOVA for Random Effect Model, Two-way Classification (one observation per cell): ANOVA for fixed effect model, ANOVA for Random Effect Model.

**Design of Experiments:** Completely Randomised Design, Randomised Block Design, Latin Square Design, their statistical analysis and variance of estimates, Analysis of Covariance.

**Multivariate Data Analysis:** Introduction, multivariate normal distributions, Mean vector, Variance-covariance matrix, Correlation matrix and their estimation for multivariate data, Step wise regression, Selection of best set of variables, Classification and discrimination problems. Factor analysis and principal component analysis. Illustrative examples and Multivariate data analysis using statistical package.

**Time Series and forecasting:** Components of time series, Analysis of time series, Measurement of trend, Measurement of seasonal variations, Measurement of cyclic variations, Auto-Regression Analysis, Auto-correlation, Random component in time series.

### **Text Books:**

1. *Medhi, J., Stochastic Processes, New Age International (2005).*
2. *Montgomery, Introduction to Statistical Quality Control, John Wiley and Sons (2005).*

### **Reference Books:**

1. *Populis, A., Random Variables and Stochastic Processes, Tata McGraw Hill (2002).*
  2. *Bhuyan, K. C., Multivariate Analysis and Its Applications, New Central Book Agency (2002).*
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**Laboratory Assignments:**

1. Analysis of variance and covariance of data.
2. Evaluation of statistical parameters of Multivariate data.
3. Analysis of time series.
4. Measurement of trend.
5. Measurement of seasonal variations.
6. Measurement of cyclic variations.
7. Auto-Regression Analysis.
8. Auto-correlation analysis.
9. Random component estimation in time series.

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/tutorials)	25

## **PIN201: SITE EXPLORATION AND FIELD TESTING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>2</b>	<b>0</b>	<b>3</b>	<b>3.5</b>

**Course Objectives:** To understand the different methods of site exploration and soil testing techniques.

**Need and importance of site investigations:** Site exploration and phasing of site exploration programme, Spacing and depth of bore holes, significant depth

**Methods of site exploration:** Soundings bore holes, drilling methods and equipment wash boring, rotary boring and percussion boring in soils at stabilization of bore holes. Procuring and handling of disturbed and undisturbed samples- various types of samplers and sampling techniques, their relative merits and suitability in particular cases, lowering of water table.

**Geophysical methods of soil exploration:** Seismic, electrical and resistivity methods, Magnetic and gravity methods, Observation of ground water level, Different methods of ground water observation, Their merits and demerits.

**Soil testing techniques:** Field tests for permeability, in place density, vane shear test, plate bearing test, standard penetration test, SCPT, CPT, Pressure meter test.

**Laboratory Work:** Tri-axial shear test, Drained and Un-drained test, Consolidation test, unconfined compressive strength test, direct shear test. Recording and reporting of data for particular engineering use e.g. for machine foundations, earth dams etc, Discussion and seminar on published papers of recent origin connected with exploration and testing of soils, case histories of failure of structures.

**Assignment /Project:** Students in groups of 4 to 6 will do the projects by conducting test like SPT, PLT and lab tests, the students will determine the safe bearing capacity for various structures like Multi-storeyed buildings, OHSR etc.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Plan the site exploration program for the construction of various structures.
2. Procure and handle the testing of disturbed and undisturbed soil samples.
3. Perform various lab tests for prediction of shear strength of soils.
4. Perform and analyse the data from various in-situ soil testing methods.

### **Recommended Books and Manuals:**

1. *Simons, Noel, Menzies, Bruce and Matthews, Marcus. Geotechnical Site Investigation, Thomas Telford Publishing, (2002).*
  2. *Hawkins, Brian. A., Site investigation Practice, Geological Society of London, (1986).*
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**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	-
2	EST	30
3	Sessionals (May include assignments/quizzes/tutorials/Seminar/Lab Viva & File)	70

## PIN202: TRANSPORTATION PLANNING AND ECONOMICS

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the concepts in the planning & economics of urban transport systems.

**Hierarchical Level of Planning:** Passenger and Goods Transportation, General Concept and Process, Urban Travel Characteristics, Private & Public Travel Behaviour Analysis Travel Demand Estimation and Forecasting, Trip Generation Methods and their Comparison, Modal Split Analysis, Behavioural Approach, Two stage Modal Split Models

**Trip Distribution:** Growth Factor Method, Gravity Model, Intervening Opportunity and Competing Opportunity Models, Entropy Maximizing and Linear Programming Methods.

**Network Assignment:** Capacity Restrained and Simultaneous Distribution, Direct Demand Models. Land-use Transport Planning, Transport Related Land use Models. Corridor Type Travel Planning, State wise and Regional Transportation Planning.

**Assignment / Project:** To perform the economical & financial analysis of the infrastructure project.

### Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Analyse the travel characteristics for the urban road network.
2. Perform Travel Demand Estimation and Forecasting.
3. Perform State wise and Regional Transportation Planning.

### Recommended Books:

1. Hutchinson, B.G., *Principles of Urban Transport Systems Planning*, McGraw Hill, New York, (1974).
2. Kadiyali, L. R., *Traffic Engineering and Transport Planning*, Khanna Publishers, (1997).
3. Michael, F., *Transportation Planning Models*, Elsevier Science Publishers, B.V. Netherlands, (1984).
4. Wright H, and Paquette, R. J., *Highway Engineering*, John Wiley & Sons, U.S.A., (1987).
5. Ortuzar, J. D., and Willumsen, L. G., *Modelling Transport*, John Wiley & Sons, New York (1994).

### Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/tutorials)	25

## **PES225: ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>1</b>	<b>0</b>	<b>3.5</b>

**Course Objectives:** To provide an overview on environmental legislation and acts applicable for environmental pollution; to facilitate understanding on role of pollution control boards and their procedure; and to facilitate understanding of various aspects related to EIA processes.

**Definition of Terms:** Conventions and protocols; Policy; law; acts and rules; Administrative and legal interpretations; Codes and specifications.

**Overview of Environmental Legislation:** Overview of Indian environmental law; Pollution control boards – Powers; functions and Procedures.

**Provisions of Water Act; Water-cess Act; Air Act; Environmental Protection Act; Public Liability Insurance Act as Applicable to Industry:** Provisions relating to Environmental clearance; Environmental sampling, analysis and reporting of results; Environmental standards; Overview of other key environmental regulations- Municipal solid waste rules; Biomedical waste rules; Hazardous waste, microorganisms, and chemicals rules;

**Legal Aspects of EIA:** EIA notification; Environmental clearance process - Screening; scoping; public consultation and appraisal; Objectives and scope of EIA; EIA process flow chart.

**Project and the Environment Description:** Environmental feasibility analysis; Baseline studies; and environmental data collection: Methods of Impact analysis- checklists; matrices; networks; overlays etc.

**EMP (Environmental Management Plan) and EIA Documentation:** Principles and Elements of approach; identification and mitigation of environmental impacts: types and structure of EIA documents.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Becoming aware of the environmental legislation, environmental policies of the country and of the international environmental conventions and protocols.
2. Knowing the environmental regulations applicable to the industry and other organizations with significant environmental aspects.
3. Knowing about the environmental requirements applicable to the environmental impact assessment, and about the environmental clearance process of developmental projects.
4. Understanding the methods and tools of identification, prediction and evaluation of environmental impacts of developmental projects.

### **Recommended Books:**

1. *CPCB, Pollution Control Law Series - PCL/2/2001; Central Pollution Control*
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Board (<http://envfor.nic.in/cpcb/cpcb.html>).

2. Jain R and Clark A, *Environmental Technology Assessment and Policy*; Ellis Harwood (1989).

3. EIA notification, *Gazette Notification: SO 1533 dated 14-09-2006; MOEF. GOI (2006)*.

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes/Lab evaluations/Tutorials)	25



## PCE101: ADVANCED STRUCTURAL ANALYSIS

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To analyze structural engineering systems by various approaches

**Stiffness Method (Systems Approach):** Basis of stiffness method, Degrees of freedom, Force-displacement relationships, Nodal stiffness.

**Flexibility Method (Systems Approach):** Flexibility coefficients, Basis of the method, Application to various types of structures.

**Introduction to Element Approach:** Member stiffness matrix, Local or Member co-ordinate system, Global or Structural co-ordinate system, Rotation of axes etc, Structure stiffness matrix.

**Structural Stability Analysis:** Elastic Instability, Introduction to stability problem, Energy methods, buckling of axially loaded members for different end conditions, Concept of effective length, approximate techniques, Stability analysis of beam-column and frames.

**Plastic Analysis:** Concept of Limit load analysis, Upper and lower bounds, Plastic analysis of beams and multi-storey frames using mechanism method.

**Non Linear Analysis:** Introduction to geometric and material non-linearity.

**Assignment/Project:** Analyse single storey single bay 3D building frame using any software and compare the results obtained manually by using displacement method.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Develop the stiffness matrix of the structures and analyze them using displacement methods
2. Develop the flexibility matrix of the structures and analyze them using force methods
3. Perform plastic analysis of various structures
4. Carry out stability analysis of columns and beam-columns for various end conditions

### **Text Books:**

1. Gere, G. M. and Weaver, Jr. W., *Matrix Analysis of Framed Structures*, CBS Publishers (1987).
2. McCormac, J. C. & Nelson, J. K., *Structural Analysis: A Classical and Matrix Approach*, John Wiley and Sons (1997).

### **Reference Books:**

1. Pandit & Gupta, *Matrix Analysis of Structures*, Tata McGraw Hill Publications (2003).
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2. *Iyengar, N.G.R., Elastic Stability of Structural Elements, Macmillan India Ltd (1980).*

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## PCE301: EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To design earthquake resistant structures as per IS guidelines

**Past Earthquakes:** Review of damage in past earthquakes.

**Earthquake response of structures,** Idealization of structures, Response spectrum analysis, Equivalent lateral force concepts, Torsionally coupled systems, Orthogonal effects, Nonlinear, Pushover and Time history analysis.

**Philosophy of earthquake resistant design:** Ductility, Redundancy & Over strength, Damping, Base Isolation Supplemental Damping, Codal Provisions.

**Seismic behaviour of Structures:** Concrete structures, Steel and masonry structures, Material properties, Analysis of members under cyclic loads, Detailing provisions, Concepts of structural control.

**Assignment/Project:** Compare the various codal recommendations of different countries with Indian standard code for earthquake resistant design of RCC and Masonry structures /Generate code compatible artificial time history acceleration compatible to IS 1893 part I 2002 code with respect to various soil & site conditions.

### Course Learning Outcomes (CLO):

After the completion of this course the student will be able to:

1. Evaluate seismic forces for various structures as per relevant Indian Standards
2. Design and ductile detailing of structures for seismic resistance as per Indian Standards
3. Apply concepts of repair and rehabilitation of earthquake affected structures

### Text Books:

1. Clough, Ray W. and Penzien, Joseph, *Dynamics of Structures*, McGraw Hill (1975).
2. Den Hartog, J. P., *Mechanical Vibrations*, McGraw Hill Book Co. (1989).

### Reference Books:

1. Timoshenko, S. P., *Vibration Problems in Engineering*, D. Van Nostrand Company Inc. (2007).
2. Aggarwal, P., Shrikhande, M., *Earthquake Resistant Design of Structures*, McGraw Hills (2003).

### Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45

3	Sessionals (May include assignments/quizzes)	25
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## PCE323: INDUSTRIAL STRUCTURES

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To analyze and design various industrial buildings

**Review of Plastic Design:** Concept of minimum weight design

**Design of Industrial Buildings:** General, Framing, Crane girders & columns, Analysis of trussed bents, Design of industrial frame.

**Design of Storage Structures:** Design of containers like bunkers, silos.

**Design of Space Structures:** Transmission towers, Steel domes, Pre-cast building components.

**Design using Light Gauge Sections:** Structural use of pressed sections and light gauge sections, Aluminium as a material of construction for industrial structures and design of such structures, Tubular structures and Sandwich plate construction.

**Aluminium structures:** Introduction, Permissible stresses, Tension members, Compression members, Design of beams, Local buckling of compression elements, Riveted and bolted construction, Design of chimneys, Load analysis, Design of steel supporting chimney, Chimney foundation

**Construction Practices:** Shop practice in steel construction, Fabrication erection and production.

**Assignment/Project:** To perform detailed analysis and design of a specific industrial building

**Course Learning Outcomes (CLO):** The students will be able to:

1. Carry out plastic design of structural elements
2. Analyze and design industrial buildings and storage structures
3. Analyze and design structures using light gauge steel and aluminium
4. To understand shop practice in steel construction including fabrication, erection and production.

### **Text Books:**

1. *Ajmani, A. L. and Arya, A. S., Design of Steel Structures, Nem Chand and Brothers (2000).*
2. *Dunham, C.W., Planning of Industrial Structures, John Wiley and Sons (2001).*

### **Reference Books:**

1. *Gary, W., Steel Designer's Manual, Prentice Hall (2008).*
  2. *Glower, F., Structural Pre-cast Concrete, Oxford Publishers (2008).*
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**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## PIN112: GEOTECHNIQUES

L	T	P	Cr
3	2	0	4.0

**Course Objectives:** To perform the analysis of Sheetpiles, Cofferdams & Earthdams.

**Sheet Piles and Cofferdams:** Types of sheet piles, principal advantages of sheet piles, analysis of cantilever wall in sands, simplified approach in clays ( $\phi = 0$ ) Anchored bulk head stability, Free earth support method, fixed earth support method. Types of cofferdams, relative merits and their advantages as compared to other types, comparison between circular and diaphragm types, failure modes of cells, stability analysis of cofferdams by TVA method. Open cuts, necessity of bracing and strutting in open cuts, pressure distribution diagram under various cases, deep open cut in loose and dense sands, deep open cut in normally loaded and stiff clays. Heaving of vertical cuts in clay

**Earth Dams: Introduction:** Historical Development, selection of dam site, types of embankment dams, choice of type of dam, components of a dam, free board, slope protection, cause of failure, criteria for safe design. Foundation Exploration and Materials for Embankments: Methods of investigations, properties of ground, field and laboratory tests, suitability criteria for materials, critical conditions in earth dam; end of construction , steady seepage, rapid draw down. Drainage of Embankment: Horizontal drain, chimney drain, design of filter, use of impervious core in seepage control.

**Control of Seepage through foundation:** General consideration, treatment of foundation; trench cut off partial cut off, grout cutoff, upstream impervious blanket, design of relief well.

**Instrumentation in Earth Dam:** Measurement of pore pressure, movement of dam and seepage, Instruments for measuring horizontal and vertical movement. Peizometers; types, choice for location, Instruments for measuring seepage.

**Stability Analysis of Slope:** Effective and total stress approach, shape of slip surface, methods of slices, graphic methods, location of critical slip circle, wedge analysis method, stability during critical conditions, stability during earth quake, Indian standard Code s of practice.

**Quality Control in Construction:** Method of compactions, quality control of compaction in the field, borrow area control.

**Arching Action in Soils:** Arching in soil, theory of arching in soils, practical utility of arching in various field problems.

**Dewatering:** Approximate computation for flow quantity to dewater an excavation, slurry wall and safety factor. Simple sketches to illustrate the principles of dewatering by different methods and their relative suitability. Ditches and sumps, well point system,



deep well drainage installation, vacuum method Bleeder wells, sand drain installation, electro-osmosis.

**Assignment / Project:** Design of sheet piles and coffer dams for a real project using site specific data.

**Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Carry out the stability analysis of the slopes by different methods.
2. Understand the different technical aspects in cofferdams and Sheetpiles.
3. Understand the instrumentation in Earth Dams.

**Recommended Books :**

1. *Murthy, V N S, A textbook of Soil Mechanics & Foundation Engineering, UBS, New Delhi (1999).*
2. *Gopal Ranjan & Rao, A S R, Basic and Applied Soil Mechanics New Age Publishers, New Delhi (2003).*
3. *Alam Singh & Chowdhry, G.R., Soil Engineering in Theory and Practice, C.B.S. Publishers, New Delhi.*
4. *Bell, F.G., Chapman and Hall, UK Engineering Treatment of Soils (1993).*
5. *Hausmann, Engineering Principles of Ground Modification, McGraw Hill, New York (1990).*
6. *Swami Saran, Analysis and Design of Substructures, Oxford and IBH, New Delhi (1998).*
7. *Bowles, J. E., Foundation Analysis & Design, McGraw Hill Publishing Co., New Delhi (1994)*

**Evaluation Scheme:**

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## **PIN 113: DESIGN OF WATER SUPPLY AND SWERAGE SYSTEMS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand various processes and design criteria involved in the treatment of water or waste water.

**Introduction:** Review of Unit processes and operations, characteristics of water and wastewater and gaseous effluents.

**Treatment Systems:** Preliminary Treatment Systems and their Design; Design of Secondary treatment units, Advanced Treatment Systems and Miscellaneous Methods

**Review of Sewage and its characteristics:** Biological Treatment, Aerobic and anaerobic processes and their applications in the waste waters treatment.

**Aerobic Treatment units:** Principles, design and operation of different systems.

**Anaerobic Treatment Units:** Principles, design and operation of different units

**Other Treatment methods:** Tertiary and other advanced treatment methods

### **Assignment/Project:**

1. Design of water supply system for the urban city.
2. Design of sewerage system for the city.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Design the various units of water supply system
2. Design the various units of waste water treatment
3. To analyse the existing water supply system to meet the demand
4. To analyse the existing sewerage system and its effective operation

### **Recommended Books:**

1. *Hammer, M.J., Water and Wastewater Technology, Regents/Prentice Hall, New Jersey (1991).*
2. *Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi (1995).*
3. *Casey T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons England (1993).*



**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## PIN114: SMART MATERIALS AND STRUCTURES

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the mechanism of working of supplementary cementing materials in concrete for production of high performance concrete

**Supplementary Cementing Materials:** Types of supplementary cementing materials such as fly ash, silica fume, rice husk ash, and metakaolin; their physical, chemical, mineralogical properties; Effects of these materials on the fresh properties; Strength properties; Durability properties.

**Fibre Reinforced Concrete:** Definition; types of fibres; Properties of fibres; Factors affecting FRC. Mixing and casting procedure; Composite materials approach; Effect of fibres on the workability, strength and durability of concretes; Applications of different types of fibres.

**High Volume Fly Ash Concrete:** Definition, Effect of types of fly ash in large quantities on the strength properties of concrete; Durability and abrasion resistance of HVFA; Applications of HVFA.

**Self-Compacting Concrete (SCC):** Definition, Advantages and disadvantages of SCC; Various mix design procedures; Tests for SCC; Applications for SCC.

**High Performance Concrete:** Definition of HPC; Material selection and its properties; Parameters for concrete being considered as HPC; Applications of HPC.

**Polymer Concrete Composites:** Definition; Types of monomers and polymers; Types of polymer concretes and their applications.

**Fibre Reinforced Plastics (FRP):** Types of FRP, their properties and effects on concrete elements under various loading conditions.

**Use of Waste Materials and By-products:** Types of waste materials and by-products such as waste glass, scrap tires, waste foundry sand, clean coal ash, etc. Effect of these materials on the various properties of mortar and concrete; Introduction of leachates from waste materials and their analysis.

**Behaviour of Concrete at High Temperature:** Definition of high temperature; Mechanism of concrete failure at high temperature; Spalling characteristics; Difference in the behaviour of normal concrete, High strength concrete and self-compacting concrete at high temperature.

### High Strength steel

**Assignment/Project:** To study different types of structural concrete and experimentally evaluate their properties.

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**Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Conceptualize the use of supplementary cementing materials in concrete
2. Understand the behaviour of properties of fly ash concrete, fibre reinforced concrete and high performance concrete
3. Understand the properties of concrete made with waste materials and industrial by-products
4. Conceptualize new developments in concrete technology in terms of Self compacting concrete, polymer concrete, FRP and concrete at high temperature

**Text Books:**

1. Neville, A. M., *Properties of Concrete*, Prentice Hall of India (1995)
2. Siddique, R., *Special Structural Concretes*, Galgotia Publications (2000)

**Reference Books:**

1. Krishna Raju, N., *Concrete Mix Design*, CBS Publications (2002)
2. Gambhir, M. L., *Concrete Technology*, Tata-McGraw Hill, 3<sup>rd</sup> Edition (2008)
3. Siddique, R., *Waste Materials and By-products in Concrete*, Springer (2008)

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

## PIN211: HYDROPOWER ENGINEERING

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand different components of hydro-power plant and use of hydropower plant.

**Introduction:** Role of Hydropower, Types of hydropower plant

**Water conveyance:** Classification and design criteria of Penstock, Anchor blocks, conduit valves, bends and manifolds, Water hammer, Surge tanks

**Turbines:** different models – classification - suitability of different types, Velocity triangles, Draft tubes, Cavitation in turbines, Performance characteristics

**Components of hydropower plants:** power system terms and definitions, water power equations, hydraulic transients, demand curve, power economics, small hydropower development.

**Assignment/Project:** Design of the hydropower unit based on the power demand for a site specific data.

### Course Learning Outcomes (CLO):

After the completion of this course the student would be able to:

1. Design the various components on a hydro power project
2. Analysis for the performance of turbines
3. Design of the hydropower unit based on the power demand

### Recommended Books:

1. Barrows, H. K., *Hydropower engineering*, McGraw-Hill Publishing Company, New York (1999).
2. Varshney, R. S., *Hydro Power Structures*, Nem Chand Brothers, Roorkee (2001).
3. Dandekar, M. M. and Sharma, K. H., *Water Power Engineering*, Vikas Publishing House, New Delhi. (1996).

### Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

## **PCE212: TALL STRUCTURES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To be able to analyze and design of tall structural systems

**Principles of Planning of Tall Buildings:** Technological Planning, Mechanical systems, Fire rating, Local considerations, Structures elements, Types of structural systems for tall buildings, Shear Walls and their arrangement

**Loads on Tall Buildings:** Gravity loads, Live loads, Wind loads and seismic loading, Code Provisions, Discussion of relevant codes of practices and loading standards, Fire Tender Loading

**Analysis of Tall Buildings (With and Without Shear Walls):** Approximate analysis for gravity loads, Lateral loads, Analysis of tube-in-tube constructional and 3-Dimensional analysis of shear core buildings, Stability, Stiffness and fatigue, Factor of safety and load factor

**Design of Tall Buildings:** Procedures of elastic design, Ultimate strength design and Limit state design of super structures including structural connections, soil structure interaction

### **Introduction to dampers**

**Assignment/Project:** Plan a tall building and perform design of shear wall for it

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Plan tall buildings considering structural systems, fire rating, local considerations etc.
2. Evaluate loading for tall structures
3. Analyze and design of tall structural systems including structural connections
4. Analyse tube-in-tube construction and 3-dimensional analysis of shear core building

### **Text Books:**

1. *Smith, Byran Stafford and Coull, Alex, Tall Building Structures: Analysis and Design, John Wiley and Sons (1991).*
2. *Taranath, B. S., Analysis and Design of Tall Buildings, Tata McGraw Hill Limited (1988).*

### **Reference Books:**

1. *Symposium on Tall Buildings with particular reference to Shear Wall Structures, held at University of Southampton (1996).*

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25





## PIN301: MASS TRANSPORTATION SYSTEMS

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To enable the students to develop the mass transportation systems

**History and role of Transit:** Recent Trends Mass Transportation Characteristics. Demand characteristics, Spatial, Temporal and Behavioural Characteristics of Transportation Demand

**Urban Mass Transportation Planning:** Demand Surveys, Estimation and Demand Projection, Four Stages of Planning. Performance Evaluation of Mass Transport System, Structure of Decision Making, Evaluation and Selection Methods, Selection Procedures, Economic Evaluation Methods

**Terminals and their Functions:** Design, Typical Characteristics. Scheduling, Service Analysis, Vehicle Dispatch Policy, Vehicle Requirements, Spacing of Bus Troops, Route Spacing and Performance

**Operational and Management Issues:** Fleet Management, Reserved Bus Lanes, Signal Preemption, Dial-a-Bus, Vehicle Monitoring and Control System, Modal Coordination, Special Studies, Underground Transportation, Para transit, Rail Transit, Case Studies

### Introduction to Integrated Transportation Systems

**Assignment/ Project:** Design & Planning of Urban Mass Transportation System.

### Course Learning Outcomes (CLO):

After the completion of this course the student would be able to:

1. Design the planning for the Urban Mass Transportation Systems.
2. Design the terminals for the transportation systems.
3. Analyse the operational and management issues in mass transportation systems.

### Recommended Books:

1. Vuchic V.R., *Urban Public Transportation System and Technology*, Prentice Hall, Inc. Englewood Cliffs, New Jersey, (1981).
2. Agarwal M.K., *Urban Transportation in India*, INAE, Allied Publishers Ltd., (1996).
3. Grey G.E. & Hoel, L. A., *Public Transportation*, Prentice Hall, Englewood Cliffs, N.J. (1992).

### Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45

3	Sessionals (May include assignments/quizzes)	25
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## **PIN213: TRAFFIC ENGINEERING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the different concepts & characteristics of the traffic.

**Traffic characteristics:** Basic characteristics of Traffic- Volume, Speed and Density- Relationship among Traffic parameters

**Traffic Measurement:** Traffic Volume Studies-Objectives- Types of Volume Studies – Concept of PCU- Data Collection and Presentation – Speed Studies – Types of Speeds- Objectives of Speed Studies- Methods of Conducting speed studies- Data collection and Presentation- Statistical Methods for Analysis of Speed Data

**Highway Capacity:** Definition of Capacity – Importance of capacity – Factors affecting Capacity- Concept of Level of Service- Different Levels of Service- Concept of Service Volume- Peak Hour Factor

**Parking Studies:** Types of parking facilities – On street and Off Street Parking Facilities- Parking Studies- Parking Inventory Study – Parking Survey by Patrolling Method- Analysis of Parking Data and parking characteristics-Multi Story Car Parking Facility- Design standards

**Traffic Control and Regulation:** Traffic Problems in Urban areas- Importance of Traffic Control and regulation- Traffic Regulatory Measures- Channelization- Traffic Signals- Saturation Flow – Signal, Design by Webster Method – Signal Phasing and Timing Diagrams

**Traffic and Environment:** Detrimental effect of traffic on environment – Air Pollution – Pollutants due to Traffic – Measures to reduce Air Pollution due to Traffic- Noise Pollution – Measures to reduce Noise Pollution

**Traffic Signs and Road markings:** Types of Traffic Signs- cautionary, Regulatory and Informative Signs- Specifications- Pavement markings- Types of Markings – Lane markings and Object markings- Standards and Specifications for Road Markings

**Highway Safety:** Problem of Highway Safety – Types of Road accidents- Causes – Engineering Measures to reduce Accidents- Enforcement Measures – Educational Measures- Road Safety Audit- Principles of Road Safety Audit

**Assignment / Project:** - To perform various traffic studies for the Urban City.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Perform the traffic volume studies.
2. Perform the parking studies.
3. Perform the Road Safety Audits.

**Recommended Books:**

1. Kadiyali, L. R., *Traffic Engineering and Transportation planning*, Khanna publishers (2008).
2. Khisty, C. J. and Lall B. K., *Transportation Engineering : An Introduction*, Prentice Hall (2002).
3. Chakroborthy, Partha and Das, Animesh, *Principles of Transportation Engineering*, Prentice Hall of India (2003).
4. Papacostas, C.S., *Fundamentals of Transportation Engineering*, Prentice Hall, India (2009).
5. Mannering, F., Kilareski W. P. and Washburn S. S., *Highway Engineering and Traffic Analysis*, John Wiley Publications (2008).

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## **PIN221: ADVANCED HYDROLOGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand different various processes involved in the hydrology and analysis of hydrologic systems

**Review of basic concepts in hydrology:** Hydrologic cycle, systems concept - hydrologic processes, precipitation, evaporation, surface flow, sub-surface flow, and groundwater flow - hill slope processes and runoff generation, Stream flow measurements

**Hydrologic Analysis:** watershed concepts, rainfall-runoff Modeling,, hydrograph analysis, unit hydrograph theory, linear and kinematic wave model, and overland flow models

**Flood routing:** Introduction to hydraulic and hydrologic routing - The Saint-Venant Equations for open channel flow, flood wave propagation, kinematic diffusion wave approximations.

**Hydrologic Statistics:** Statistical parameter estimation, probability distribution, goodness of fit, Time Series Analysis - Hydrologic real time forecasting; Probability, risks and uncertainty analysis for hydraulic and hydrologic design; Regional Flood Frequency analysis.

**Hydrologic Simulation Models:** Hydrologic model classification, philosophy of mathematical models of watershed hydrology, steps in watershed modeling, major hydrologic models.

### **Urban watershed Hydrology**

**Ground Water Hydrology:** Well hydraulics, Analysis of pumping test data, Groundwater recharge;

### **Water logging and salinity**

**Assignment/ Project:** Hydrological analysis of a catchment.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. To design the various hydrologic processes and their governing equations
2. To analyse the flood routing through an open channel
3. To analyse the hydrologic system statistically to predict the probable occurrences of an hydrologic event
4. To learn the efficient use of ground water and its management

### **Recommended Books:**

1. Chow, V. T et al., *Applied Hydrology*, McGraw-Hill Publishing Company, New York (1988).

2. *Haan, C.T, Statistical methods in Hydrology, Iowa State University Press (2002).*
3. *McCuen, R.H., Modelling Hydrologic Change – Statistical methods, Lewis Publishers (2002)*
4. *Mays, L. W., Water Resources Engineering, John Wiley and Sons (2009).*
5. *Todd, D. K., Groundwater Hydrology, John Wiley and Sons, New York ( 2006).*

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

## **PIN222: GROUND IMPROVEMENT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the different ground improvement techniques for different types of soil.

**General Principal of Compaction:** Mechanics, field procedure, quality control in field

**Ground Improvement in Granular Soil:** In place densification by Vibrofloatation, Compaction pile, Vibro Compaction Piles, Dynamic Compaction, and Blasting

**Ground Improvement in Cohesive Soil:** Preloading with and without vertical drains. Compressibility, vertical and radial consolidation, preloading methods. Types of Drains, Design of vertical Drains, construction techniques. Stone Column: Function Design principles, load carrying capacity, construction techniques, settlement of stone column foundation

**Ground Improvement by Grouting: Grouting** in soil, types of grout, desirable characteristics, grouting pressure, grouting methods

**Soil Reinforcement:** Mechanism, Types of reinforcing elements, reinforcement-soil interaction, Reinforcement of soil beneath the roads, foundation. Stability and Design of Reinforced earth retaining wall Types of geosynthetics, Physical and Engineering properties of geosynthetics. Functions of geosynthetics, applications and designing with geosynthetics in pavement, foundations, embankments, retaining walls and filtration

**Soil Stabilization:** Lime stabilization-Base exchange mechanism, Pozzolanic reaction, lime-soil interaction, lime columns, Design of Foundation on lime columns. Cement stabilization: Mechanism, amount, age and curing. Fly-ash – Lime Stabilization, Soil Bitumen Stabilization

**Assignment / Project:** Design and analysis for the RE walls for the highway projects

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Use the techniques of ground improvement in cohesive and granular soils.
2. Perform the Stability analysis and Design of Reinforced earth retaining wall.
3. Perform the various soil stabilization techniques.

### **Recommended Books:**

1. *Raj Parshotham; Geotechnical Engineering, Pearson Education(2009).*
2. *F.G. Bell; Engineering Treatment of Soils, E & FN Spon Publishers, UK (2001).*
3. *Moseley M.P.; Ground Improvement, Blackie A&P(2000).*
4. *Saran Swami; Reinforced Soil and its Engineering Applications, I.K. International (2006).*

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25





## **PIN223: DESIGN OF PAVEMENTS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>2</b>	<b>0</b>	<b>4</b>	<b>4.0</b>

**Course Objectives:** To understand the various design & maintenance aspects of the pavements.

**Importance and functions of various component of pavement structures:** Stresses in flexible pavements, Analytical techniques, Multilayered solutions, Design concepts, Sub grade stresses and deflection, Shear failures, equivalent single wheel and axle loads, vehicle Damage factor, Loading characteristics, Static, Impact and repeated loads, Effects of dual and tandem axles. Tyre pressure and total load, Equivalent stress and equivalent deflection criterion, wheel load, climatic and environmental factors, structural and functional distress in pavements

**Design of flexible & rigid pavements:** CBR method, Triaxial method, Mcleod method, Analytical methods, Multilayer elastic theory and design, Design for low cost pavements, Rigid pavements, Equivalent wheel load, Stresses, Sub grade theories, Westergaard' s analysis , Methods of design for dense liquid, Elastic solid sub grades, Temperature stresses and their evaluation, CRC Pavements Prestressed concrete slabs, Tie bars, Dowel bars, SFRC pavements, Pavement flexible and rigid overlay, IRC method of design.

**Pavement Management Process:** Pavement Evaluation and Performance. Design Alternatives; Analysis Evaluation and Selection, implementation of PMS. Case Studies related to PMS.

### **Assignments / Projects:-**

1. Design the flexible pavement as per IRC 37:2012 for the given traffic data.
2. Design the rigid pavements as per the IRC guidelines.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Perform the design of the flexible pavements using different IRC design methods.
2. Perform the design of the rigid pavements using different IRC design methods.
3. Develop the Pavement Maintenance Management systems for the flexible & rigid pavements.

### **Recommended Books:**

1. *Yoder, E.J., Principles of Pavement Design, 2<sup>nd</sup> Edition, John Wiley & Sons, Inc. New York, (1975).*
  2. *Khanna & Justo, Highway Engineering – Nem Chand & Brothers, Roorkee,(1997).*
  3. *Kadiyali L. R. Principles & Practice of Highway Engg. Khanna Pub. (2000).*
  4. *Chakroborty , P., Das A, Principles of Transportation Engg., PHI, (2005).*
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**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## PIN224: INTELLIGENT TRANSPORTATION SYSTEMS

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the implementation of intelligent transportation systems.

**Advanced traveller information systems:** transportation network operations; commercial vehicle operations and intermodal freight

**Public transportation applications;** ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions, ITS and safety

**ITS as a technology:** deployment program, research, development and business models, ITS and sustainable mobility, travel demand management, electronic toll collection, and ITS and road-pricing

**Use of ITS for remote monitoring of bridge performance**

**Assignment / Project:** Case study of ITS in public transportation system.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Implement the ITS in public transportation systems.
2. Use ITS for the travel demand management.
3. Use ITS for evaluation of bridge performance.

### **Recommended Books:**

1. *Chris Drane, Chris Rizos, Positioning Systems in Intelligent Transportation Systems, Artech House, (1998).*
2. *Chen, K and Miles John, ITS Handbook: recommendations from the World Road Association (PIARC), (2000).*
3. *Joseph Sussman, Introduction to Transportation Systems, Artech House, (2000).*
4. *Jotin Khisty, C. and Kent Lall, B. Transportation Engineering: An introduction, Prentice Hall of India, (2003).*

### **Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

## **PCE211: ADVANCED BRIDGE DESIGN**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To analyze and design various types of bridges

**General:** Bridge System, Considerations in alignment, Planning, Economic consideration, Aesthetics and selection of type of bridge (Review)

**Loading Standards:** Standards followed in U.K., U.S.A. and Europe

**Super Structure Analysis:** Bridge deck analysis using different methods, Load distribution theories – Courbon specifications for loading, Geometrical proportioning etc. of road, rail-cum-road bridges, Indian Road Congress (IRC) and Indian Railway Loading standards and their comparison with loading, Hendry-Jaegar, Morris-Little (Orthotropic plate theories) methods, Stiffness method, Finite difference method, Folded Plate method, Finite strip method and Finite Element method (General treatment), Limit analysis, Design of bridge decks.

**Continuous Bridges:** Introduction to IRC 112: Provisions of Earthquake Resistant Design of Bridges

**Connections:** Design of different connections, Bearings and joints

**Substructure Analysis and Design:** Piers, Abutments, Wing walls and other appurtenant structures

**Foundations:** Well foundations and pile foundation, Design and construction and field problems

**Construction & Maintenance:** Erection of bridge super structure, Maintenance, Rating and Strengthening of existing bridges

**Dynamics Behaviour:** Behaviour of bridges under dynamic loads, Discussion of code provisions for design of bridges for wind and earthquake forces

**Long Span Bridges:** General discussion of suspension and cable stayed bridges

**Assignment/Project:** To design sub and super structure of RCC bridge

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Understand the concept of planning and investigation for bridges
  2. Analyze and design superstructures for various types of rcc bridges
  3. Analyze and design various types of substructures and foundations
  4. Perform dynamic analysis of bridges
-

**Text Books:**

1. Bakht, B. and Jaeger, L.G., *Bridge Analysis Simplified*, McGraw-Hill Book Company (1985).
2. Cusens, A.R. and Parma, R.P., *Bridge Deck Analysis*, John Wiley & Sons Ltd. (1975).
3. Hambly, E.C., *Bridge Deck Behaviour*, Chapman and Hall. (1991).

**Reference Books:**

1. Krishna Raju, N., *Design of Bridges*, Oxford and IBH Publications (1998).
2. Ponnuswamy, R., *Bridge Engineering*, Tata McGraw Hill (1997) .
3. *Relevant Road & Railway Codes for Bridges*.
4. Raina, V K , *Concrete Bridge Practice*, Tata McGraw Hill Publications(1991)

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## **PIN311: MECHANICS OF SEDIMENT TRANSPORT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand various processes involved in the transportation of sediment in an open channel

**Importance of sediment transport:** Properties of sediment, Laminar and turbulent boundary flows, rough and smooth bed

**Particle properties and mechanics:** Particle settling, Forces on particles in fluid, initiation of motion and transport processes

**Modes of sediment transport:** Bed load, suspended load, Mechanics of sediment transport, Shield's Entrainment method, Flow regimes and resistance, Bed formations, Form drag and grain roughness Computation of suspended load: Rouse equation, sediment concentration curve

**Computation of bed load:** Mathematical equations for bed load, Empirical formulas, Einstein's bed load equation, Regime concept, Design of stable channels, Kennedy's and Lacey's theory, seepage effects

**Riverine morphology and sediment transport phenomena:** Channel classification and transport regimes, River meandering and braiding, aggradation and degradation, scour around bridge piers River training works

**Assignment/ Projects:** Experimental analysis of sediment transport in an open channel flow.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student would be able to:

1. Understand the sources of the sediment in an open channel
2. Understand the problems associated with the excess sediments and its controlling variables
3. Predict the scour phenomenon in an alluvial channel
4. Predict the bedforms and sediment loads in an alluvial channel

### **Recommended Books:**

1. Graf, W.H., *Hydraulics of Sediment Transport*, McGraw Hill series in Water Resources and Environment Engineering, (1971).
2. Roudkivi, A.J., *Loose Boundary Hydraulics*, Pergamon Press, (1967).
3. Yang, C.T., *Sediment transport theory and practice*, Krieger Publisher, (2003).
4. Julien, P.Y., *Erosion and Sedimentation*, Cambridge University Press, (1998).

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## PIN312: RETAINING STRUCTURES

<b>L</b>	<b>T</b>	<b>P/D</b>	<b>Cr</b>
<b>3</b>	<b>0</b>	<b>2</b>	<b>4.0</b>

**Course Objectives:** To understand the design concepts of various retaining structures

**Design of tanks:** Types and Design joints, cylindrical tanks and towers, Rectangular tanks on ground, underground and O.H.S.R.S., Hydrodynamic pressures under earthquakes

**Design of Intze tank:** Design of cylindrical and Intze tanks as shells of revolution taking into account the effects of continuity

**Design of water towers:** With parallel and splayed legs for wind and earthquake forces

**Silos and Bunkers:** General, Johnson's theory, Airy's Theory, Design of silos and bunkers by limit state theory

**R.C.C. Pipes:** Introduction. Stresses due to hydrostatic pressure, self weight and weight of water, earth fill over haunches, uniformly distributed load on top, design of pipes

### Soil Retention Systems

**Assignment /Project:** Structural design of retaining structures for the infrastructure projects.

### Course Learning Outcomes (CLO):

After the completion of this course the student would be able to:

1. Design the ground, underground and overhead reservoirs
2. Design the Intze tank and water towers.
3. Design the silos and bunkers.

### Recommended Books:

1. Dayaratnam P., *Design of Reinforced Concrete Structures*, Oxford IBH Publications, New Delhi, (1983).
2. IS 3370 codes on liquid retaining structures
3. Jaikrishan & Jain., *Plain & Reinforced Concrete, Vol. II*, Nem Chand and Bros, Roorkee, (1963).
4. Punmia, B.C., *Reinforced Concrete Structures, Vol. II*, Standard Publishers, (1992).
5. SP: 16 -Design Aids to IS:456-1978, Bureau of Indian Standards

### Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## **PIN313: REHABILITATION OF STRUCTURES**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the various concepts of repairs, rehabilitation and retrofitting of structures

**Maintenance and repair strategies:** Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of distress and deterioration of concrete- Evaluation of existing buildings through field investigations, Seismic evaluation of existing buildings

**Serviceability and durability of concrete:** Quality assurance for concrete construction concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

**Materials and techniques for repair:** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Guniting and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning - Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection.

**Repairs, Rehabilitation and Retrofitting of structures:** Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure - Special techniques for structural Retrofitting (Bracing, Shear walls, Base isolation etc).

**Demolition techniques:** Engineered demolition techniques for Dilapidated structures – case studies - Case Studies on Restoration of fire damaged buildings, Case study on repairs and strengthening corrosion damaged buildings; Case study on use of composite fibre wraps for strengthening of building components.

**Assignment / Project:-**Case studies of retrofitted structures.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Develop various maintenance and repair strategies.
2. Evaluate the existing buildings through field investigations.
3. Understand and use the different techniques for structural retrofitting.

**Recommended Books:**

1. *Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical UK, (1991).*
2. *R.T. Allen and S.C. Edwards, Repair of Concrete structures, Blakie and Sons, UK, (1987)*
3. *M. S. Shetty, Concrete Technology – Theory and Practice, S. Chand and Company, New Delhi, (1992).*
4. *Santhakumar, A.R., Training Course notes on Damage Assessment and repairs in Low Cost Housing, “RHDC – NBO” Anna University, July (1992).*
5. *Raikar, R., Learning from failures – Deficiencies in Design, Construction and Service – R & D centre (SDCPL), RaikarBhavan, Bombay, (1987).*
6. *N. Palaniappan, Estate Management, Anna Institute of Management, Chennai, (1992).*
7. *Lakshmipathy, M. et al. Lecture notes of Workshop on Repairs and Rehabilitation of Structures, 29 -30th October 1999, (1999).*

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25



## **PIN314: ADVANCED RAILWAY AND AIRPORT ENGINEERING**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the various advanced aspects of railway and airport engineering.

**Railway:** Importance of transportation systems. History of railways and its development, development of Indian Railways - Surveys for Route location - Permanent way and its component parts Formation, Ballast, Sleepers, Rails. Creep and Tilt in Rails. Track fittings and fastenings - Points and crossings - Track resistance and tractive effort. Gauge problem, super- elevation near branching of curves; gradients - Station Platforms - Various types of yards and sidings - Signals.

**Airport Engineering:** Introduction, classification of airports; planning, Surveys and site selection of airports.

**Airport Geometrics:** Runway Length, Patterns and orientation- wind rose diagram - Width and grades of runway; Taxiways and aprons.

**Airport Pavement Design:** Difference between Highway and airport pavements; Introduction to various design methods. LCN-ACN methods of the Pavement Evaluation. Pavement Management Systems for the airport pavements. Airport drainage.

### **Assignment / Project:**

1. To design the flexible & rigid runway & apron pavements.
2. To design the turnout as per the Indian Railway specifications.

### **Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Design the permanent way sections for the railways.
2. Perform the geometric design of runways and taxiways.
3. Design & evaluate the various airport pavements.
4. Develop the Pavement Management System for airport pavements.

### **Recommended Books:**

1. Rangawala, S.C., *Railway Engineering*, Charotar Publishers, Anand, (2002).
2. Arora, S.P. and Saxena., *Railway Engineering*, Dhanpat Rai Publishers, New Delhi, (2001).
3. Khanna, Arora and Jain. *Airport Planning and Design*, Nem Chand and Brothers, Roorkee, (2002).
4. Robert Horenjeff; *Planning and Design of Airports* (2<sup>nd</sup> edition), McGraw Hill Book Co.

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

## **PIN315: DISASTER MITIGATION AND MANAGEMENT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
<b>3</b>	<b>2</b>	<b>0</b>	<b>4.0</b>

**Course Objectives:** To understand the various aspects of disaster mitigation and management.

**Natural Disasters:** Meaning and nature of natural disasters, their types and effects - Floods, drought, cyclone, earthquakes, landslides, avalanches

**Earthquake:** Description, Causes of earthquakes, distribution of earthquakes, Mitigation and management

**Flood hazards - Control and management:** Causes of floods, Environmental risks, Methods of flood forecasting, Mitigation planning in a flood prone area, flood plain management, Measures to mitigate flood damage, Flood control economics

**Volcanic eruptions, Heat and cold waves, ozone depletion**

**Climatic change:** global warming, Sea level rise

**Man Made Disasters:** Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents

**Disaster Management:** Meaning, concept, principles, scope, objectives, and approaches. Element of disaster management; International strategy for disaster reduction; Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community – based organizations and media; Central, state, district and local administration

**Disaster Mitigation:** Hazard assessment, Vulnerability assessment, Risk assessment

**Remote-sensing and GIS applications:** Applications real time disaster monitoring, prevention and rehabilitation, Case Studies

**Assignment / Project:** Case study of the frameworks of various disaster management systems

### **Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Develop the framework for the disaster management & disaster mitigation.
2. Classify various types of the natural and manmade disasters.
3. Use the GIS and Remote sensing techniques for the real time disaster monitoring.

**Recommended Books:**

1. *Scneid, T and Collins, L., Disaster management and preparedness, Lewis Publishers, Washington, D.C. (1998).*
2. *Goel, S. L. Encyclopaedia of Disaster Management, Deep & Deep Publications Pvt. Ltd., (2006).*
3. *Ghosh, G.K., Disaster Management, A.P.H. Publishing Corporation, (2006).*
4. *Edwards, B., Natural Hazards, Cambridge University Press, UK, (2005).*
5. *Central Water Commission, Manual of flood forecasting, New Delhi, (1989).*
6. *Ahmad, Shaik Iftikhar, Disaster management in the wake of flood, Twenty first century publication, Patiala, (2008).*

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

**PIN391: SEMINAR**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
-	-	-	<b>4.0</b>

**Course Objectives:** This course is designed to help the students to obtain skills to discuss or present something within a group. Seminar presentation of ME Seminar Course is an outcome of six months of study, exploration, survey and analysis of a particular topic.

**Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Identification of a domain specific scholarly topic
2. Investigate and tabulate details and history about the selected topic
3. Application of the selected topic in domain or real life
4. Technical report writing

**PIN392: MINOR DESIGN PROJECT**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
-	-	-	<b>4.0</b>

**Course Objectives:** This course is designed to encourage design projects where students take what they've learned throughout the course of their ME program and apply it to examine a specific idea.

**Course Learning Outcomes (CLO):**

After the completion of this course the student will be able to:

1. Investigate and identify real world problems
2. Design , develop and implement a domain specific project



**PIN491: DISSERTATION**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>
-	-	-	<b>16.0</b>

**Course Objectives:** To expose students to research work in the area of their interest

Extensive research is carried out on one topic by each student by conducted experiments in the lab or by developing analytical models by using software's. They shall be evaluated on the basis of dissertation report and viva-voce examination.

**Course Learning Outcomes (CLO):**

The students will be able to:

1. Develop acumen for higher education and research.

**Evaluation Scheme:**

<b>Sr. No.</b>	<b>Evaluation Elements</b>	<b>Weightage (%)</b>
1	Research paper	10
2	Report	50
3	External Evaluation	40