PRIST
DEEMED TO BE
UNIVERSITY
NAAC ACCREDITED
THANJAVUR – 613 403 - TAMIL NADU

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

PROGRAM HANDBOOK

M.TECH (STRUCTURAL ENGINEERING)

FULL TIME

[REGULATION 2022]

[for candidates admitted to M.Tech (Structural Engineering) program from June 2022 onwards]

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the Programme ME Structural Engineering will

PEO1 Gain knowledge and skills in structural engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations

PEO2 Become consultants in Structural Engineering and solve complex real-life issues related to the analysis, design and maintenance of structures under various environmental conditions.

PEO3 Contribute to the enhancement of knowledge in Structural Engineering by performing Quality research in institution s of international repute or Research organizations or Academia.

PEO4 Practice their profession with good communication, leadership, ethics and social responsibility and formulate solutions that are technically sound, economically feasible, and Socially acceptable.

PEO5 Graduates will function in multi-disciplinary teams and adapt to evolving technologies through life-long learning and innovation

PROGRAMME OUTCOMES(POs)

PO1	An ability to independently carry out research/investigation and development work to Solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the Requirements in the appropriate bachelor's program

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PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of the program M.E. Structural Engineering will be able to

PSO1	Knowledge of Structural Engineering discipline	Acquire in-depth knowledge of the Structural Engineering discipline, with an ability to evaluate, analyze and synthesize existing and new knowledge in structural design.
PSO2	Critical analysis of Structural Engineering issues and innovation	Critically analyze complex Structural Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical ,practical and policy context.
PSO3	Conceptualization and evaluation of Engineering solutions to Structural Design issues	Conceptualize and solve Structural Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration Of health, safety, and socio-cultural factors

PEO/PO Mapping:

PEO	PO			PSO		
	PO1	PO2	PO3	PSO1	PSO2	PSO3
I	-	2	3	3	3	3
II	1	3	3	3	2	1
III	3	3	2	2	3	3
IV	1	1	-	-	1	3
V	2	-	1	1	3	-

(3-High, 2-Medium,1-Low)

COURSE STRUCTURE

SEMESTER DETAILS

CREDITS DISTRIBUTION

S. No	SEMESTER	TOTAL CREDITS
1	SEMESTER I	26
2	SEMESTER II	24
3	SEMESTER III	23
4	SEMESTER IV	15
Total		88

SEMESTER – I

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22248S11E	Advanced Engineering Mathematics	3	1	0	4
2	22255C12	Quality Control &Assurance in Construction	3	1	0	4
3	22255C13	Theory of Plasticity and Elasticity	3	1	0	4
4	22255C14	Structural Dynamics	3	1	0	4
5	22255C15	Experimental Techniques	3	1	0	4
6	22255E16A	Hard Core Elective I	3	1	0	3
7	22255L17	Core Practical (Computer Programming Lab)	0	0	3	3
		TOTAL				26

SEMESTER – II

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255C21	Management Information System	3	1	0	4
2	22255C22	Finite Element Analysis	3	1	0	4
3	22255C23	Advanced Concrete Structural Design	3	1	0	4
4	22255E24B	Hard Core Elective –II	3	1	0	3
5	22255E25C	Hard Core Elective –III	3	1	0	3
6	22255L26	Core practical(Software Lab – Finite Element Analysis- ANSYS)	0	0	3	3
7	222TECWR	Technical writing / Seminars	0	0	3	3
TOTAL						24

SEMESTER – III

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255C31	Advanced Steel Structures	3	1	0	4
2	22255E32C	Hard Core Elective IV	3	1	0	3
3	22255E33A	Hard Core Elective V	3	1	0	3
4	22255E34B	Hard Core Elective VI	3	1	0	3
5	22255P35	Project Work Phase-I	0	0	6	10
TOTAL						23

SEMESTER – IV

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255P41	Project Work Phase-II	0	0	12	15
TOTAL						15

LIST OF ELECTIVES
Hard Core Elective-I

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255E16A	Prestressed Concrete Design	3	1	0	3
2	22255E16B	Theory of Plates	3	1	0	3
3	22255E16C	Water Resource Engineering	3	1	0	3
4	22255E16D	Soil Structural Interaction	3	1	0	3
5	22255E16E	Remote Sensing Essentials	3	1	0	3

Hard Core Elective – II

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255E24 A	Analysis And Design Of Tall Buildings	3	1	0	3
2	22255E24 B	Advanced Concrete Technology	3	1	0	3
3	22255E24 C	Soil Dynamics	3	1	0	3
4	22255E24 D	Rock Engineering	3	1	0	3
5	22255E24 E	Advanced Soil Mechanics	3	1	0	3

Hard Core Elective - III

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255E25A	Design of sub structure	3	1	0	3
2	22255E25B	Advanced Foundation Engineering	3	1	0	3
3	22255E25 C	Elements of Earthquake Engineering	3	1	0	3
4	22255E25 D	Development and Applications of Special Concretes	3	1	0	3
5	22255E25 E	Vibration of Continuous Systems	3	1	0	3

Hard Core Elective-IV

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255E32A	Optimization of Structures	3	1	0	3
2	22255E32B	Wind And Cyclone Effects On Structures	3	1	0	3
3	22255E32C	A seismic Design of Structures	3	1	0	3
4	22255E32D	Urban Transportation System Planning	3	1	0	3
5	22255E32E	Applied Seismology for Engineers	3	1	0	3

Hard Core Elective – V

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255E33A	Prefabricated Structures	3	1	0	3
2	22255E33B	Design Of Bridges	3	1	0	3
3	22255E33C	Surface Water Hydrology	3	1	0	3
4	22255E33D	Unsaturated Soil Mechanics	3	1	0	3
5	22255E33E	Remote Sensing and GIS for rural development	3	1	0	3

Hard Core Elective – VI

S. No	Subject Code	Name of the Subject	L	T	P	C
1	22255E34A	Offshore Structures	3	1	0	3
2	22255E34B	Structural Dynamics	3	1	0	3
3	22255E34C	Water Supply Engineering	3	1	0	3
4	22255E34D	Water and waste water treatment	3	1	0	3
5	22255E34E	Applied Environmental Microbiology	3	1	0	3

22248S11E ADVANCED ENGINEERING MATHEMATICS L T P C
3 1 0 4

AIM & OBJECTIVES:

The course aim to develop the skills of the students in the areas of boundary value problems and transform techniques. The course will also serve as a prerequisite for post Graduate and specialized studies and research.

Be capable of mathematically formulating certain practical problems in terms of partial differential equations, solve them and physically interpret the results.

Have learnt the basics of Z – transform in its applicability to discretely varying functions, gained the skill to formulate certain problems in terms of differences equations.

UNIT I LAPSE TRANSFORMATION 12

Laplace transform methods for one-dimensional wave equation – Displacement in a long string – longitudinal vibration of an elastic bar – Laplace equation – properties of harmonic functions.

UNITII FOURIER TRANSFORM 12

Fourier transforms methods for one – dimensional heat conduction problems in infinite and semi infinite rod – Fourier transform methods for Laplace equation.

UNITIII PROBABILITY& DISTRIBUTION 12

Probability – definition and introduction – random variable – probability density functions – study of standard distributions: Binomial, Poisson, normal exponential and Weibull distributions – Applications – Baye's theorem.

UNITIV TESTING OF HYPOTHESIS 12

Testing of Hypothesis – Parametric test – Small samples – Test related proportion, Means, Standard deviation – Test based on chi-square, Goodness of fit and test of independence.

UNIT V THEORY OF ESTIMATION 12

Principles of least squares – Multiple and partial correlation and regression – Estimation of parameters – Method of moments.

TOTAL: 60 PERIODS

REFERENCE BOOKS:

1. Sankar Rao.K., Introduction to partial differential equations, Pnentile Hall of India, New Delhi – 1995.
2. Sneddon.I.N., Elements of partial differential equations, MC Graw Hill, 1996
3. Engineering Statistics, Bowher and Liberman
4. Gupta.S.C. & Kappor, V.K. Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Reprint 1999.

OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

CO1: Application of Laplace and Fourier transforms to the initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

CO2: Maximizing and minimizing the functions that occur in various branches of Engineering Disciplines.

CO3: Construct on formal mappings between various domains and use conformal mapping in

Studying problems in physics and engineering, particularly fluid flow and heat flow problems.

CO4: Understand tensor algebra and its applications in applied sciences and engineering and develops the ability to solve mathematical problems involving tensors.

CO5: Competently use tensor analysis as a tool in the field of applied sciences and related fields.

COs-PO's & PSO's MAPPING

	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**
CO1	1	-	3	-	-	-
CO2	2	1	3	-	-	-
CO3	2	1	3	-	-	-
CO4	2	1	3	-	-	-
CO5	2	1	3	-	-	-
Avg.	**1.8**	**0.8**	**3**	**-**	**-**	**-**

22255C12 QUALITY CONTROL AND ASSURANCE IN CONSTRUCTION **L T P C 3 1 0 4**

OBJECTIVE:

- To understand the elements of quality planning and the implication
- To become aware of objectives and advantage of quality assurance
- To be exposed to means of quality control
- To study the relationship between quality control and assurance

UNIT-I **12**

Construction Organisation and Quality Planning: Types of organizations - Inspection, control and enforcement - Quality Management Systems and method - Responsibilities and authorities in quality assurance and quality control - Architects, engineers, contractors, and special consultants, Quality circle.

UNIT-II **12**

Quality policy, Objectives and methods in Construction Industry - Consumers satisfaction, Ergonomics - Time of Completion - Statistical tolerance - Taguchi's concept of quality - Codes and Standards - Document - Contract and construction programming - Inspection procedures - Processes and products - Total QA I QC programme and cost implication.

UNIT-III **12**

Quality Assurance: Objectives - Regularity agent, owner, design, contract and construction oriented objectives, methods - Techniques and needs of QA/QC - Different aspects of quality - Appraisals, Factors influencing construction quality - Critical, major failure aspects and failure mode analysis, -Stability methods and tools, optimum design - Reliability testing, reliability coefficient and reliability prediction.

UNIT-IV **12**

Quality Control: Total Quality Control- Quality Control by statistical methods — Sampling by attributes and by variables - Selection of new materials - Influence of drawings, detailing, specification,

UNIT-V **12**

Standardization - Bid preparation - Construction activity, environmental safety, social and environmental factors - Natural causes and speed of construction - Life cycle costing -Value engineering and value analysis.

TOTAL: 45 PERIODS

REFERENCES BOOKS:

1. O'Brian, James J. "Construction Inspection Handbook - Quality Assurance and Quality Control", Van Nostrand, New York, 1989.
2. Tenah, Kwaku A. and Guevara, Jose M., "Fundamentals of Construction Management and Organization", Reston Publishing Co., Inc., Virginia, 1985.
3. Oglesby, Clarkson H. "Productivity Improvement in Construction", McGraw-Hill, New Delhi,1989

COs-PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	3
2	3	3	3	3	3	2
3	3	2	3	3	2	2
4	3	2	2	3	2	2
5	3	3	2	3	3	2
Avg	**3**	**2.4**	**2.4**	**3**	**2.4**	**2.2**

22255C13 THEORY OF PLASTICITY AND ELASTICITY L T P C
3 1 0 4

OBJECTIVES:

Emphasis is placed on static problems with linear material and small deformation. Many basic 2-D problems (such as plane strain and plane stress) and 3-D problems.

UNIT I ANALYSIS OF STRESS AND STRAIN 12

Analysis of stress and strain, stress strain relationship. Generalized Hook's law. Plane stress and plane strain.

UNIT II DEFORMATION 12

Basic concepts of deformation of deformable bodies - Transformations of stresses and strains in Cartesian and polar co-ordinates - Equilibrium equations in two and three dimensions in Cartesian co-ordinates.

UNIT III TORSION 12

Torsion of non-circular section - methods of analysis - membrane analogy - torsion of thin rectangular section and hollow thin walled sections.

UNIT IV THEORY OF ENERGY 12

Energy methods – Energy principles and theorem.

UNIT V INTRODUCTION TO PROBLEMS IN PLASTICITY 12

Physical assumption - criteria of yielding, yield surface, Flow rule (plastic stress strain relationship). Elastic plastic problems of beams in bending - plastic torsion.

TOTAL: 60 PERIODS

REFERENCES:

1. Timoshenko, S. and Goodier T.N. "Theory of Elasticity", McGraw Hill Book Co., New York, II Edition 1988.
2. Chwo P.C. and Pagano, N.J. "Elasticity Tensor, Dyadic an Engineering applications", D.Van Nestrand Co., In Co., 1967.
3. Chenn, W.P. and Henry D.J. "Plasticity for Structural Engineers", Springer Verlag New York 1988.
4. Mendelson, A., (2002), Plasticity: Theory & Applications, Mac Millan & Co., NewYork.
5. Sadhu Singh, (2004), Theory of Plasticity, Dhanpat Rai sons Private Limited,New Delhi.

OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

CO1 Derive and write the fundamental equations of elasticity describing the linear behavior of elements and develop constitutive models based on material behavior

CO2 Demonstrate the application of plane stress and plane strain in a given situation in both cartesian and polar coordinate systems

CO3 Solve torsion problems in circular and non-circular cross-sections

CO4 Analyse beams resting on elastic foundations

CO5 Solve analytically the simple boundary value problems with elasto-plastic and strain hardening properties

COs-PO's&PSO'sMAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	3
2	3	3	3	3	3	2
3	3	2	3	3	2	2
4	3	2	2	3	2	2
5	3	3	2	3	3	2
Avg	**3**	**2.4**	**2.4**	**3**	**2.4**	**2.2**

22255C14 STRUCTURAL DYNAMICS L T P C
3 1 0 4

AIM AND OBJECTIVES:

This course covers the methods for analyzing the stresses and deflections developed in any given type of structures when it is subjected to an arbitrary dynamic loading.

UNIT I PRINCIPLES OF DYNAMICS 12

Formulation of equations of motion by different methods, single degree freedom systems, free and forced response, effect of damping.

UNIT II MULTIDEGREE OF FREEDOM SYSTEMS 12

Formulation of structure property matrices, Eigen values problems, Modes shapes and ortho normality of modes, Approximate methods of extraction of eigen values.

UNIT III DYNAMIC RESPONSE OF MDOF SYSTEMS 12

Mode superposition techniques, Numerical integration procedures.

UINT IV CONTINUOUS SYSTEMS 12

Modeling - free and forced vibration of bars and beams.

UNIT V APPLICATIONS 12

Idealisation of structures to mathematical models, examples of wind, earthquake and impact

TOTAL: 60 PERIODS

REFERENCES:

1. Mario Paz, Structural Dynamics, CBS, Publishers, 1987.
2. Roy R Craig, Jr., Structural Dynamics, John Wiley & Sons, 1981.
3. Clough and Penzien, (2000), Dynamics of Structures, Second Edition, McGraw Hill Book Company.

OUTCOMES:

On completion of this course, the student is expected to be able to

CO1 Do vibration analysis of system/structures with a single degree of freedom and can explain the method of damping the systems

CO2 Do the dynamic analysis of system/structures with Multi degrees of freedom under free and forced vibration

CO3 Derive a mathematical model of a continuous system and do a dynamic analysis under free and forced vibration

CO4 Explain the causes and effects of an earthquake

CO5 Design masonry and RC structures for the earthquake forces as per their commendations of IS codes of practice

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	2
2	3	2	3	3	2	2
3	3	2	2	3	3	2
4	3	1	-	3	-	1
5	3	3	1	3	3	2
Avg	**3**	**2.20**	**2.25**	**3**	**2.75**	**1.80**

22255C15 EXPERIMENTAL TECHNIQUES L T P C
3 0 0 3

OBJECTIVE:

- To learn the principles of measurements of static and dynamic response of structures andcarryout the analysis of results.

UNIT I FORCES AND STRAIN MEASUREMENT 9

Choice of Experimental stress analysis methods, Errors in measurements - Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines – Long- term monitoring – vibrating wire sensors– Fibre optic sensors.

UNIT II MEASUREMENT OF VIBRATION AND WIND FLOW 9

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – wind tunnels – Flow meters – Venturimeter – Digital data Acquisition systems.

UNIT III DISTRESS MEASUREMENTS AND CONTROL 9

Diagnosis of distress in structures – Crack observation and measurements – corrosion of reinforcement in concrete – Half cell, construction and use – damage assessment – controlled blasting for demolition – Techniques for residual stress measurements – Structural Health Monitoring.

UNIT IV NON DESTRUCTIVE TESTING METHODS 9

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission

– ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating, Advanced NDT methods – Ultrasonic pulse echo, Impact echo, impulse radar techniques, GECOR , Ground penetrating radar (GPR).

UNIT V MODEL ANALYSIS 9

Model Laws – Laws of similitude – Model materials – Necessity for Model analysis – Advantages – Applications – Types of similitude – Scale effect in models – Indirect model study – Direct model study - Limitations of models – investigations – structural problems –Usage of influence lines in model studies.

TOTAL : 45 PERIODS

OUTCOME:

- At the end of this course students will know about measurement of strain, vibrations andwind blow.
- They will be able to analyze the structure by non-destructive testing methods and modelanalysis.

REFERENCES:

1. Dalley .J. W and Riley. W. F, “Experimental Stress Analysis”, McGraw Hill Book Company,
   N.Y. 1991
2. Ganesan.T.P, “Model Analysis of Structures”, University Press, India,

2000.
3. Ravisankar.K.and Chellappan.A., "Advanced course on Non-Destructive Testing and Evaluation of Concrete Structures", SERC, Chennai, 2007.
4. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2006.
5. Sirohi.R.S., Radhakrishna.H.C, "Mechanical Measurements", New Age International (P)Ltd. 1997.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	2
2	3	2	3	3	2	2
3	3	2	2	3	3	2
4	3	1	-	3	-	1
5	3	3	1	3	3	2
Avg	**3**	**2.20**	**2.25**	**3**	**2.75**	**1.80**

CORE PRACTICAL -I

22255L17 COMPUTER PROGRAMMING LAB- AUTO CAD L T P C
3 0 0 3

AIM:

To impart knowledge to analyze solve, design and Civil Engineering drawings using
AutoCAD.

OBJECTIVES:

- To learn the basic concepts of computing.
- To know the methodology of problem solving.
- To develop civil engineering drawing using Auto CAD**.**

UNIT I

Introduction AutoCad – Definition of various commands used in AutoCAD

UNIT II

Simple Exercises using AutoCad commands – Produce drawing using AutoCad and output of all the drawings are taken print out in A4 sheet using Inkjet / Laser Printer or Plotter and produced in file form as regard.

UNIT III

Section of semicircular Arch, Section of a lean – to – roof and section of spread footing foundation

UNIT IV

Plan, section and elevation of a prayer hall, school building and residential building (R.C.C. Roof)

UNIT V

Preparation of approval drawing to be submitted to corporation or municipality showing required details in one such as site plan, ground floor plan, section and elevation, key plan, septic tank plan, rain water harvesting pit with all details and title block detail.

TOTAL: 45 PERIODS

REFERENCES

1. Building drawing – Shah, Tata McGraw-Hill
2. Building planning & Drawing – Dr. N. Kumaraswamy, A. Kameswara Rao, Charotar Publishing.
3. Shah, Kale and Patki, Building Drawing, Tata McGraw-Hill.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	2
2	3	2	3	3	2	2
3	3	2	2	3	3	2
4	3	1	-	3	-	1
5	3	3	1	3	3	2
Avg	**3**	**2.20**	**2.25**	**3**	**2.75**	**1.80**

SEMESTER II

22255C21 MANAGEMENT INFORMATION SYSTEM L T P C
3 1 0 4

OBJECTIVE:

• To bring about an exposure to information systems in a formal manner
• To study the development of information systems
• To study the means of applying information systems models to project management
• To introduce system audit and to study its features

UNIT-I **12**

System Development: Information Systems - Establishing the Framework - Business Models -Evolution of Information Systems. Modern Information System - System Development Life Cycle - Structured Methodologies - Designing Computer Based Methods, Procedures, Control -Designing Structured Programs.

UNIT-II **12**

Information Systems: Integrated Construction Management Information System – Project Management Information System - Functional Areas, Finance, Marketing, Production, Personnel .

UNIT-III **12**

Levels, DSS, EIS, ES - Comparison, Concepts and Knowledge Representation – Managing International Information System.

UNIT-IV **12**

Implementation and Control: Control - Testing Security - Coding Techniques - Defection of Error -Validating - Cost Engineering qualities - Design, Production, Service, Software specification.

UNIT-V **12**

Software Metrics, Software quality assurance - Systems Methodology - Objectives - Time and Logic, Knowledge and Human Dimension - Software life cycle models - Verification and Validation.

TOTAL: 60 PERIODS

REFERENCES BOOK:

1. Laudon, Kenneth C and Laudon, Jane Price. “Management Information Systems:
Organisation and Technology”, Prentice Hall of India, New Delhi, 1996.
2. Elam, Jo.yce J. “Case Series for Management Information Systems, Simon and Schuster”, Custom Publishing, 1996.
3. Sprague, Ralph H and Watson, Huge J. “Decision Support for Managers”, Prentice Hall,NewJersey,199

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	3	3	3	3	2
2	3	2	3	3	2	2
3	3	2	2	3	3	2
4	3	1	-	3	-	1
5	3	3	1	3	3	2
Avg	**3**	**2.20**	**2.25**	**3**	**2.75**	**1.80**

22255C22 **FINITE ELEMENT ANALYSIS** **L T P C**
3 1 0 4

OBJECTIVES:

The finite element method is the most powerful structural analysis tool for the Civil Engineers. The basic formulation and programming technique are introduced. According to the same procedures, the different elements such as truss, beam, plate and shell are easily formulated.

UNIT I INTRODUCTION **12**

Differential equilibrium equations - strain displacement relation - linear constitutive relation - special cases. Principle of stationary potential energy - application to finite element methods. Some numerical techniques in finite element Analysis

UNIT II ANALYSIS OF PLATE BENDING **12**

Two Dimensional problems - Plane Stress, Plain Strain and Axisymmetric Problems - Triangular and beam element -. Analysis of plate bending - Basic theory of plate bending- displacement functions - plate bending Elements.

UNIT III MODELS AND FUNCTION OF ELEMENT **12**

Displacement models - convergence requirements. Natural coordinate systems – Shape function. Interpolation function. Linear and quadratic elements - Lagrange & Serendipity elements.

UNIT IV ANALYSIS OF NONLINEAR AND VIBRATION PROBLEMS12

Strain displacement matrix - Material and Geometric Nonlinearity - Methods of Treatment -Dynamic condensation-Eigen value extraction

UNIT V ASSEMBLAGE OF ELEMENT **12**

Assemblage of elements – Direct stiffness method. Special characteristics of stiffness matrix - Boundary condition & reaction - Gauss elimination –Basic steps in Finite element analysis.

TOTAL: 60 PERIODS

REFERENCES

1. Krishnamoorthy, C.S, Finite Element Analysis Theory & Programming, McGraw- Hill
2. Desai C.S and Abel, J.F., Introduction to the finite element Method, AffiliatedEast west Press Pvt. Ltd. New Delhi 1997.
3. Bathe , K.J., Finite Elements Procedures in Engineering analysis, Prentice Hall Inc., 1995.

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Formulate a finite element problem using basic mathematical principles

CO2 Explain the various types of elements and select the appropriate element for modeling

CO3 Analyse a frame using truss element

CO4 Formulate and analyse the two- and three-dimensional solid finite element problems

CO5 Analyse shells, thick and thin plates and explain the dynamic analysis using FEM

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	2	2	2
2	3	3	-	2	2	2
3	3	2	3	2	3	2
4	3	2	3	2	3	2
5	3	3	2	2	3	2
Avg	**3**	**2.4**	**2.75**	**2**	**2.6**	**2**

22255C23 ADVANCED CONCRETE STRUCTURAL DESIGN L T P C
3 1 0 4

OBJECTIVES:

To impart knowledge about the performance of concrete as structural material and the behavior, elastic and inelastic, of reinforced – concrete members and structures, designing structures safely, economically and efficiently**.**

UNIT I INTRODUCTION 12

The nature of concrete- Behaviour of concrete - stress-strain relationships of concrete, - stress-strain relationships of reinforcing steel- Failure criteria for concrete (crack width calculation is must).

UNIT II REVIEW OF OVERALL DESIGN 12

Limit state analysis and design of beams in flexure - Behavior of reinforced concrete members in bending - Plastic hinge – Rotation capacity – Factors affecting rotation capacity of a section – Plastic moment – Moment curvature relationship – Redistribution of moments.

UNIT III STRUCTURAL DESIGN 12

Limit state design of deep beams. Design of Flat Slabs using BIS 456. Design of slender columns subjected to combined bending moment and axial force using SP 16 .

UNIT IV SHEAR WALL 12

Analysis and design of shear wall framed buildings**.**

UNIT V DUCTILITY 12

Detailing for ductility - fire resistance of buildings - field control of concrete

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explain the structural behaviour of flexural members and columns

CO2 Design the compression members and construct interaction diagrams

CO3 Design the special elements like corbels, deep beams and grid floors

CO4 Design flat slab and spandrel beams

CO5 Predict the moment curvature behavior and design and detail concrete elements based on ductility.

REFERENCE

1. Krishnaraju, (1998), Advanced Concrete Design, CBS Publishers and distributors, Delhi.

2. Varghese P.C, Design of Reinforced Concrete Structures, Prentice hall of India.

3. Krishnamurthy, K.T, Gharpure S.C. and A.B. Kulkarni – Limit design of reinforced concrete structures, Khanna Publishers, 1985.

4. Unnikrishna Pillai -TMH Books

5. Jain and Jaikrishna, (2002), Plain and reinforced concrete, Vol. II, Nemi

Chand
Bros., Roorkee.
6. Durham, (2003), Advanced Concrete Design, Oxford Publishing private
Limited.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	-	-	3	2	2
2	3	2	2	3	2	2
3	3	2	2	3	2	2
4	3	2	2	2	3	2
5	3	2	2	2	3	2
Avg	**3**	**2**	**2**	**2.6**	**2.4**	**2**

22255L26 **SOFTWARE LAB** **L T P C**
3 0 0 3

AIM:

To impart knowledge to analyze solve, design and Civil Engineering drawings using
FEA - ANSYS

OBJECTIVES:

- To learn the basic concepts of computing.
- To know the methodology of problem solving.
- To develop Civil Engineering drawing using FEA – ANSYS

LIST OF EXPERIMENTS

1. Calculate the displacement and the member forces / reaction for the given simple truss with concentrated loads.
2. Calculate the displacement and the member forces / reaction for the given Stepped shaft subjected to temperature change.
3. Calculate the displacement and the member forces / reaction for the given beam with concentrated and distributed loads.
4. Find the natural frequencies and mode shapes of a given cantilever beam.
5. Find the maximum normal stress and stress concentration factor for the given plate with hole.

REFERENCES:

1.Fundamentals of Finite element analysis, David V. Hulton, Publisher-MC Graw – Hill Science.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	1	2
2	3	-	-	2	1	2
3	2	1	2	2	3	2
4	2	-	2	2	2	2
5	2	3	3	2	2	1
Avg	**2.4**	**1.2**	**2**	**2.2**	**1.8**	**1.8**

SEMESTER III

22255C31	ADVANCED STEEL STRUCTURES	L	T	P	C
		3	1	0	4

OBJECTIVES:

Introduction to steel structure, tensioned member, compressed member, beam, design of beam and column, bolt jointing, welding jointing and other joint design.

UNIT I COMPRESSION MEMBERS **12**

Design of compression members – Axially – Uniaxial and biaxial bending.

UNIT II PLASTIC ANALYSIS **12**

Plastic Analysis of Structures – Introduction - Shape factors – Mechanisms - Plastic hinge - Analysis of beams and portal frames - Design of continuous beams.

UNIT III LIGHT WEIGHT STEEL STRUCTURES **12**

Design of Light Gauge Steel Structures - Types of cross sections - Local buckling and lateral buckling - Design of compression and tension members – Beams - Deflection of beams.

UNIT IV LIMIT STATE DESIGN **12**

Limit state design of Steel Structures – Plastic section – Section classification – Partial safety factor.

UNIT V DESIGN OF JOINTS AND CONNECTIONS **12**

Design of joints and connections – Riveted – Bolted – Welded – Semi rigid connection.

TOTAL: 60 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Design the steel members such as purlins, gable wind girders subjected to combined forces

CO2 Explain and design different types of steel connections such as welded and bolted flexible as well as moment resisting connections

CO3 Analyze and design industrial structures such as trusses and portal frames subjected to wind and seismic forces

CO4 Explain the effect of axial force and shear force on steel structures and analyse continuous beams and frames using plastic theory

CO5 Evaluate the behaviour and design of compression and flexural Cold-formed Steel members

REFERENCE

1.Horne, M.R., and Morris, L.J., (1996), Plastic Design of Low-rise frames, Granada Publishing Ltd; N.Y.

2. Salmon, C.G., and Johnson, J.E., (2000), Steel Structures – Design and Behaviour, Harper and Row.

3.Kuzamanovic, B.O. and Williams, N., (1997), Steel Design for Structural Engineers, Prentice Hall.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	3	3
2	3	2	3	3	3	2
3	3	3	2	3	3	2
4	3	2	2	3	2	3
5	3	2	2	3	2	3
Avg	**3**	**2.2**	**2.4**	**3**	**2.6**	**2.6**

LIST OF ELECTIVES
SEMESTER I
HARD CORE ELECTIVE- I

22255E16A PRESTRESSED CONCRETE DESIGN L T P C
3 1 0 4

AIM AND OBJECTIVES:

This course introduces students to the fundamental principles of pre-stressed concrete behavior and design, So that they can act effectively to optimize existing forms of construction and apply fundamental concepts with confidence in unusual and challenging situations**.**

UNIT I INTRODUCTION 12

Difference between reinforced and pre-stressed concrete – Principles of pre-stressing – Methods and systems of pre-stressing – Principles of electro thermal pre-stressing and chemical pre-stressing – Classification of pre-stressed concrete structures – Materials – High strength concrete and High strength steel – Stress-strain diagram - Losses in pre- stress.

UNIT II LIMIT STATE DESIGN 12

Design of prismatic pre-stressed concrete members for bending at working loads –Check for ultimate load stage (Limit State Design).

UNIT III BEHAVIOR OF BEAMS 12

Simple cable profiles – Calculation of deflections – Design of beams for shear and torsion at working and ultimate loads. Design of Anchorage zone by Guyon's method – Concept of Magnel's method – IS 1343 recommendations.

UNIT IV COMPOSITE BEAMS 12

Composite pre-stressed concrete beams – Design procedure – Calculation of stresses at important stages both for propped and un propped constructions – Shrinkage stresses.

UNIT V BEHAVIOR OF CONTINUOUS BEAMS 12

Statically indeterminate structures – Concept of concordant cable and linear transformations – Sketching of pressure lines for continuous beams – Circular pre stressing.

TOTAL: 60 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Identify the various methods of prestressing and estimate the loss
CO2 Design the beams for flexure, shear, bond and torsion
CO3 Design the continuous beams and composite beams
CO4 Design the water tank, piles and masts
CO5 Analyze and design the prestressed concrete bridge

REFERENCES:

1. Leonhardt.F., Prestressed Concrete, Design and Construction, Wilhelm Ernst and Shon,Berlin, 1964.
2. Freyssinet, Prestressed Concrete
3. Krishna Raju, N.Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 1986.
4. Rajagopal.N, (2005), Prestressed Concrete, Second Edition, Narosa

Publishing House.
5. Dayarathnam P, (2004), Prestressed Concrete Structures, S.Chand Publishers.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	3	1	2
2	3	-	-	2	1	2
3	2	1	2	2	3	2
4	2	-	2	2	2	2
5	2	3	3	2	2	1
Avg	**2.4**	**1.2**	**2**	**2.2**	**1.8**	**1.8**

22255E16B **THEORY OF PLATES** **L T P C**
3 0 0 3

OBJECTIVE:

- To study the behavior and analysis of thin plates and the behaviour of anisotropic andthick plates.

UNIT I INTRODUCTION TO PLATES THEORY **9**

Thin Plates with small deflection.Laterally loaded thin plates, governing differential equation,various boundary conditions.

UNIT II RECTANGULAR PLATE **9**

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation. Moody's chart (for analysis of plates with various boundary conditions/loading)

UNIT III CIRCULAR PLATES **9**

Symmetrical bending of circular plates.

UNIT IV SPECIAL AND APPROXIMATE METHODS **9**

Energy methods, Finite difference and Finite element methods.

UNIT V ANISOTROPIC PLATES AND THICK PLATES **9**

Orthotropic plates and grids, moderately thick plates.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course students will be able to analyze different types of plates (rectangular and circular) under different boundary connections by various classical methods and approximate methods.
- They will also know behavior of orthotropic and thick plates and grids.

REFERENCES:

1. Ansel C.Ugural, "Stresses in plate and shells", McGraw Hill International Edition, 1999.
2. Bairagi, "Plate Analysis", Khanna Publishers, 1996.
3. Bulson.P.S.,"Stability Of Flat Plates.,American Elsevier Publisher. Co.,1969.
4. Chandrashekahara, K. Theory of Plates, University Press (India) Ltd., Hyderabad, 2001.
5. Reddy J N, "Theory and Analysis of Elastic Plates and Shells", McGraw Hill BookCompany, 2006.
6. Szilard, R., "Theory and Analysis of Plates – classical and numerical methods, PrenticeHall Inc., 2004.
7. Timoshenko.S.P, and Krieger S.W. "Theory of Plates and Shells", McGraw Hill BookCompany, New York, 2003.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E16C WATER RESOURCE ENGINEERING L T P C
4 0 0 4

OBJECTIVES:

To introduce students to various components and design of water supply scheme, water treatment methods, water storage distribution system, sewage treatment and disposal and deign of intake structures and sewerage system.

UNIT I WATER SUPPLY 12

Estimation of surface and subsurface water resources - Predicting demand for water- Impurities of water and their significance - Physical, chemical and bacteriological analysis - Waterborne diseases - Standards for potable water. Intake of water: Pumping and gravity schemes.

UNIT II WATER TREATMENT 12

Objectives - Unit operations and processes - Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation – Clarifloccuator - Plate and tube settlers - Pulsator clarifier - sand filters - Disinfection - softening, removal of iron and manganese - Defluoridation - Softening - Desalination process - Residue Management - Construction, Operation and Maintenance aspects

UNIT III WATER STORAGE AND DISTRIBUTION 12

Storage and balancing reservoirs - types, location and capacity. Distribution system: layout, hydraulics of pipe lines, pipe fittings, valves including check and pressure reducing valves, meters, analysis of distribution systems, leak detection, maintenance of distribution systems, pumping stations and their operations - House service connections.

UNIT IV PLANNING AND DESIGN OF SEWERAGE SYSTEM 12

Characteristics and composition of sewage - Population equivalent - Sanitary sewage flow estimation - Sewer materials - Hydraulics of flow in sanitary sewers - Sewer design - Storm drainage-Storm runoff estimation - Sewer appurtenances - Corrosion in sewers - Prevention and control – Sewage pumping-drainage in buildings - Plumbing systems for drainage

UNIT V SEWAGE TREATMENT AND DISPOSAL 12

Objectives - Selection of Treatment Methods - Principles, Functions, - Activated Sludge Process and Extended aeration systems - Trickling filters - Sequencing Batch Reactor(SBR) - UASB - Waste Stabilization Ponds - Other treatment methods - Reclamation and Reuse of sewage - Recent Advances in Sewage Treatment - Construction, Operation and Maintenance aspects. - Discharge standards-sludge treatment -Disposal of sludge

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1 Understand the various components of water supply scheme and design of intake structureand conveyance system for water transmission

CO2 Understand on the characteristics and composition of sewage, ability to estimate sewage generation and design sewer system including sewage pumping stations

CO3 Understand the process of conventional treatment and design of water and wastewater treatment system and gain knowledge of selection of treatment process and biological treatmentprocess

CO4 Ability to design and evaluate water distribution system and water supply in buildings and understand the self-purification of streams and sludge and septage disposal methods.

CO5 Able to understand and design the various advanced treatment system and knowledge aboutthe recent advances in water and wastewater treatment process and reuse of sewage

TEXTBOOKS:

1. Garg, S.K. Environmental Engineering, Vol.I Khanna Publishers, New Delhi, 2010.
2. Modi, P.N., Water Supply Engineering, Vol.I Standard Book House, New Delhi, 2016.
3. Garg, S.K., Environmental Engineering Vol.II, Khanna Publishers, New Delhi, 2015.
4. Duggal K.N., "Elements of Environmental Engineering" S. Chand and Co. Ltd., New Delhi,2014.
5. Punmia, B.C., Jain, A.K., and Jain.A.K.., Environmental Engineering, Vol.II, LaxmiPublications, 2010.

REFERENCES:

1. Punmia B.C, Ashok Jain and Arun Jain, Water Supply Engineering, Laxmi Publications (P)Ltd., New Delhi 2010.
2. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development,Government of India, New Delhi, 1999.
3. Syed R. Qasimand Edward M. Motley Guang Zhu, Water Works Engineering Planning, Design and Operation, Prentice Hall of India Learning Private Limited, New Delhi, 2009.
4. Of Urban Development, Government of India, New Delhi, 2013.
5. Metcalf and Eddy – Waste water Engineering – Treatment and Reuse, Tata Mc. Graw – HillCompany, New Delhi, 2010.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E16D SOIL STRUCTURAL INTERACTION L T P C
3 0 0 3

OBJECTIVE:

To study the concept of soil-structure – interaction in the analysis and design of structures.

UNIT I SOIL-FOUNDATION INTERACTION 9

Introduction to soil-foundation interaction problems – Soil behaviour – Foundation behavior Interface behaviour- Scope of soil foundation interaction analysis- soil response models–Elastic continuum- Two parameter elastic models- Elastic-plastic behaviour- Timedependent behaviour.

UNIT II BEAM ON ELASTIC FOUNDATION- SOIL MODELS 9

Infinite beam – Two-parameters models – Isotropic elastic half space model – Analysis ofbeams of finite length – combined footings.

UNITIII PLATES ON ELASTIC CONTINUUM 9

Thin and thick rafts – Analysis of finite plates - Numerical analysis of finite plates.

UNIT IV ANALYSIS OF AXIALLY AND LATERALLY LOADED PILES AND PILEGROUPS 9

Elastic analysis of single pile – Theoretical solutions for settlement and load distributions – Analysis of pile group – Interaction analysis – Load distribution in groups with rigid cap – Loaddeflection prediction for laterally loaded piles – Subgrade reaction and elastic analysis – Interaction analysis – Pile-raft system.

UNIT V GROUND-FOUNDATION-STRUCTURE INTERACTION 9

Effect of structure on ground-foundation interaction – Static and dynamic loads- Contact pressure and its estimation – Estimation of the settlement from the constitutive laws – Free-fieldresponse – Kinetic interaction – Inertial interaction

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explain the concept of soil structure interaction.

CO2 Do a static analysis of infinite and finite beams resting on elastic foundation

CO3 Analyse finite thin and thick plates

CO4 Do a static and dynamic analysis of soil structure interaction problems

CO5 Analyze ground foundation and structure interaction problems

REFERENCES:

1. John P. Wolf, (1985) Soil-structure interaction, Prentice Hall, 1987.
2. Bowels, J.E., "Analytical and Computer methods in Foundation" McGraw Hill Book Co.,New York., 1974
3. Desai C.S. and Christian J.T., "Numerical Methods in Geotechnical ngineering" McGrawHill Book Co. New York,1977.
4. Soil Structure Interaction, the real behaviour of structures, Institution of Structural Engineers,1989.
5. A.P.S. Selvadurai, Elastic Analysis of Soil Foundation Interaction, Developments inGeotechnical Engg.vol-17, Elsevier Scientific Publishing Co., 1979.
6. Prakash, S., and Sharma, H. D., "Pile Foundations in Engineering Practice."John Wiley &Sons, New York, 1990.
7. Rolando P. Orense, Nawawi Chouw& Michael J. Pender – Soil-Foundation-StructureInteraction.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E16E REMOTE SENSING ESSENTIALS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements ofdata interpretation

UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck‘s law, Wien’s Displacement Law, Stefan’s Boltzmann law, Kirchoff‘s law – Radiation sources: active & passive - Radiation Quantities

UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction ofradiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

UNIT III ORBITS AND PLATFORMS 9

Motions of planets and satellites – Newton‘s law of gravitation - Gravitational field and potential - Escape velocity - Kepler‘s law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Legrange Orbit.

UNIT IV SENSING TECHNIQUES 9

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV
– Orbital and sensor characteristics of live Indian earth observation satellites

UNIT V DATA PRODUCTS AND INTERPRETATION 9

Photographic and digital products – Types, levels and open source satellite data products – selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 understand the concepts and laws related to remote sensing

CO2 understand the interaction of electromagnetic radiation with atmoshphere and earthmaterial

CO3 acquire knowledge about satellite orbits and different types of satellites

CO4 understand the different types of remote sensors

CO5 gain knowledge about the concepts of interpretation of satellite imagery

TEXTBOOKS:

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.

2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third EditionUniversities Press (India) Private limited, Hyderabad, 2018

REFERENCES:

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.I, AmericanSociety of Photogrametry, Virginia, USA, 2002.
2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and JacobVanZyl, 2006 Edition II, Wiley Publication.
5. Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011 CRC Press, Taylor& Francis Group, London, UK, 2010

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

SEMESTER II

HARD CORE ELECTIVES-II

22255E24A ANALYSIS AND DESIGN OF TALL BUILDINGS L T P C

3 0 0 3

OBJECTIVE:

- To study the behaviour, analysis and design of tall structures.

UNIT I LOADING AND DESIGN PRINCIPLES 9

Loading- sequential loading, Gravity loading, Wind loading, Earthquake loading, - Equivalent lateral force, modal analysis - combination of loading, – Static and Dynamic approach - Analytical and wind tunnel experimental methods - Design philosophy - working stress method, limit state method and plastic design.

UNIT II BEHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9

Factors affecting growth, height and structural form. High rise behaviour, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega systems.

UNIT III ANALYSIS AND DESIGN 9

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist - Computerized three dimensional analysis – Assumptions in 3D analysis – Simplified 2D analysis.

UNIT IV STRUCTURAL ELEMENTS 9

Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

UNIT V STABILITY ISSUES 9

Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course students will be able to know the behavior of tall buildings due to various types of loads.
- They will be able to analyze and design such buildings by approximate, accurate and simplified methods.

REFERENCES:

1. Beedle.L.S., “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi, 1986.
2. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”, John Wiley and Sons, Inc., 2005.

3. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
4. Lin T.Y and Stotes Burry D, "Structural Concepts and systems for Architects and Engineers", John Wiley, 1988.
5. Taranath B.S., "Structural Analysis and Design of Tall Buildings", McGraw Hill, 1988.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E24B ADVANCED CONCRETE TECHNOLOGY L T P C
3 1 0 4

AIM AND OBJECTVES:

- To learn the Performance of concrete as structural material and advanced technologies used in construction by using concrete.

UNITIINTRODUCTION TO CONCRETE 12

Materials - Concrete materials - Reinforcements and admixtures.

UNIT II MIXDESIGN 12

Mix Design – Specifications - Design of concrete mixes by IS code method – ACI method - Road Note No:4 method – High strength concrete.

UNIT III BEHAVIOUROFCONCRETE 12

Behaviour of Concrete - Modern trends in concrete manufacture and placement techniques - Theological behaviour of fresh concrete and hardened concrete - Resistance to static and dynamic loads.

UNIT IV TESTING 12

Testing of Concrete - Non-destructive testing and quality control – Durability - Corrosion protection and fire resistant.

UNIT V SPECIAL CONCRETE 12

Special Concrete - Pre-cast concrete - Light weight concrete - Under water concrete -Pumped concrete - Polymer concrete - Composites and fibre reinforced concrete.

TOTAL:60 PERIODS

REFERENCES :

1. Neville, A.M.(2003), Properties of Concrete, Standard Publishers Distributors.
2. Varshney(2000), Concrete Technology, Khanna Publishers, New Delhi.
3. IS : 383 – 1970, (2005), Specification for Coarse and fine natural sources for Concrete, BIS, New Delhi.
4. IS : 9103-1979, (2005), Specification for Admixtures for Concrete, BIS, New Delhi

COs-PO's & PSO's MAPPING

	PO01	PO02	PO03	PO04	PO05	PO06
CO1	1	-	3	-	-	-
CO2	2	1	3	-	-	-
CO3	2	1	3	-	-	-
CO4	2	1	3	-	-	-
CO5	2	1	3	-	-	-
Avg.	**1.8**	**0.8**	**3**	**-**	**-**	**-**

22255E24C **SOIL DYNAMICS** **L T P C**
3 0 0 3

COURSE OBJECTIVE:

To design different types of machine foundations based on thedynamic properties of soils and to get an exposure on vibration isolation techniques.

UNIT I THEORY OF VIBRATION **9**

Introduction – Nature of dynamic loads – Basic definitions – Simple harmonic motion – Fundamentals of vibration – Single degree and multi degree of freedom systems – Free vibrations of spring – Mass systems – Forced vibrations – Resonance – Viscous damping –Principles of vibrations measuring systems – Effect of transient and pulsating loads.

UNIT II DYNAMIC SOIL PROPERTIES **9**

Dynamic stress-strain characteristics – Principles of measuring dynamic properties – Laboratorytechniques – Field tests – Block vibration test – Factors affecting dynamic properties – Typical values. Mechanism of liquefaction – Influencing factors – Evaluation of liquefaction potential – Analysis from SPT test – Dynamic bearing capacity – Dynamic earth pressure.

UNIT III MACHINE FOUNDATIONS **9**

Introduction – Types of machine foundations – General requirements for design of machine foundations – Design approach for machine foundation – Vibration analysis – Elastic Half-Spacetheory – Mass-spring-dashpot model – Permissible amplitudes – Permissible bearing pressures.

UNIT IV DESIGN OF MACHINE FOUNDATION **9**

Evaluation of design parameters – Types of Machines and foundations – General requirements –their importance – Analysis and design of block type and framed type machine foundations – Modes 135 of vibration of a rigid foundation – Foundations for reciprocating machines, impact machines, Two – Cylinder vertical compressor, Double-acting steam hammer – Codalrecommendations - Emprical approach – Barken's method – Bulb of pressure concept – Pauw's analogy – Vibration table studies.

UNIT V VIBRATION ISOLATION **9**

Vibration isolation – Types of isolation – Transmissibility – Passive and active isolation – Methods of isolation – Use of springs and damping materials – Properties of isolating materials –Vibration control of existing machine foundation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to;

CO1 Acquire knowledge to apply theories of vibration to solve dynamic soil problems.

CO2 Evaluate the dynamic properties of soil using laboratory and field tests.

CO3 Acquire basic knowledge about machine foundations and design various types of machinefoundation.

CO4 To know and capable of selecting the types of vibration isolation materials.

CO5 To apply vibration isolation techniques for various field problems.

REFERENCES:

1. KameswaraRao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing, NewDelhi, 2000.
2. Prakash, S and Puri, V.K., Foundations for machines, McGraw Hill, 1987.
3. Moore, P.J.,Analysis and Design of Foundations for Vibrations, Oxford and IBH, 1985.
4. Vaidyanathan, C.V., and Srinivasalu, P., Handbook of Machine Foundations, McGraw Hill,1995.
5. Arya, S., O'Nelt; S., Design of Structures and Foundations for Vibrating Machines, PrenticeHall, 1981.
6. Major, A., Vibration Analysis and Design of Foundations for Machines and Turbines, Vol. I.II and III Budapest, 1964.
7. Barkan, D.D., Dynamics of Basis of Foundation, McGraw Hill, 1974.
8. Swami Saran, Soil Dynamics and Machine Foundation, Galgotia publications Pvt. Ltd. NewDelhi 2010.
9. Das B.M., Principles of Soil Dynamics, McGraw Hill, 1992.
10. Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International series,Pearson Education (Singapore) Pvt Ltd, 2004.
11. KameswaraRao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, NewDelhi, 1998.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E24D **ROCK ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

Students are expected to classify, understand stress-strain characteristics, failure criteria, and influence of in-situ stress in the stability of various structuresand various technique to improve the in-situ strength of rocks.

UNIT I CLASSIFICATION OF ROCKS **9**

Types of Rocks - Index properties and classification of rock masses, competent and incompetentrock - value of RMR and ratings in field estimations.

UNIT II STRENGTH CRITERIA OF ROCKS **9**

Behaviour of rock under hydrostatic compression and deviatric loading - Modes of rock failure planes of weakness and joint characteristics - joint testing, Mohr - Coulomb failure criterion and tension cutoff. Hoek and Brown Strength criteria for rocks with discontinuity sets.

UNIT III INSITU STRESSES IN ROCKS **9**

In-situ stresses and their measurements, Hydraulic fracturing, flat jack, over coring and under coring methods - stress around underground excavations – Design aspects of openings in rocks.

UNIT IV SLOPE STABILITY AND BEARING CAPACITY OF ROCKS **9**

Rock slopes - role of discontinuities in slop failure, slope analysis and factor of safety - remedial measures for critical slopes – Bearing capacity of foundations on rocks.

UNIT V ROCK STABILIZATION **9**

Stabilization of rocks-rock support and rock reinforcement-active and passive supports-ground response curve-support reaction curve-reinforcement of fractured and joined rocks-Shotcreting bolting-anchoring-installation methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Classify the Rock mass and rate the quality of rock for tunnelling and foundations worksand suggest the safer length of tunnelling and stand-up time.

CO2 Apply the knowledge of engineering and understand the stress – strain characteristics andfailure criteria of rock and apply them to arrive at the shear strength parameters of rocks to be used for the design of structures resting on rock and also for the design of underground excavation in rocks.

CO3 Apply the knowledge of engineering and assess the influence of in-situ stress in thestability of various underground excavations and also acquire the knowledge of design ofopening in rocks.

CO4 Apply the knowledge on rock mechanics and analyze the stability of rock slopes and arriveat the bearing capacity of shallow and deep foundations resting on rocks considering the presence of joints. design the foundations resting on rocks. Able to carry-out suitable foundationfor the structure resting on rock.

CO5 Improve the in-situ strength of rocks by various methods such as rock reinforcement and rock support. Able to select suitable support system considering the interaction between rock andsupport. Also capable of executing the same in the field.

REFERENCES:

1. Goodman, R.E., Introduction to rock mechanics, John Willey and Sons, 1989.
2. Hudson, A. and Harrison, P., Engineering Rock mechanics – An introduction to the principles,Pergamon publications, 1997.
3. Hoek, E and Bray, J., Rock slope Engineering, Institute of Mining and Metallurgy, U.K. 1981.
4. Hoek, E and Brown, E.T., Underground Excavations in Rock, Institute of Mining andMetallurgy, U.K. 1981.
5. Obvert, L. and Duvall, W., Rock Mechanics and the Design of structures in Rock, John Wiley,1967.
6. Bazant, Z.P., Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.Wittke, W., Rock Mechanics. Theory and Applications with case Histories,Springerverlag, Berlin, 1990.
7. Waltham, T, Foundations of Engineering Geology, Second Edition, Spon Press, Taylor &Francis Group, London and New York, 2002.
8. Ramamurthy T., "Engineering in Rocks for Slopes Foundations and Tunnels", PHI LearningPvt. Ltd., 2007

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E24E ADVANCED SOIL MECHANICS L T P C
3 0 0 3

OBJECTIVE:

To impart knowledge required for computing stress and settlement at any point in the semiinfinite elastic soil medium, anisotropic medium and layered deposits due to foundation loads and evaluation of stability of foundations, slopes, cuts and retaining structures both for the conditions of undrained and drained loading through theorems of plastic collapses.

UNIT I THEORY OF ELASTICITY 12

Material behavior – Basic Concepts – Elastic, Viscous and Plastic idealization, Mechanics of Continua: Stress and strain - concept of stress and strain – Three dimensional and Two dimensional state of stress – Plane stress, plane strain and axisymmetric problems – equilibrium and compatibility conditions, constitutive relations, stress functions – Two dimensional problems in Cartesian and polar co-ordinates.

UNIT II STRESS AND DISPLACEMENT IN EASTIC – HALF SPACE MEDIUM 14

Elastic half-space medium – Stress by external loads – Isotropic, anisotropic and nonhomogeneous elastic continuum – Boussinesq, Frochlich, Westergaard solutions for force on the surface of semi-infinite medium – Kelvin, Cerruti and Mindlin's method for force in interior of semiinfinite medium, solutions by influence charts – Elastic displacement – Layered soil – Burmister method.

UNIT III THEOREMS OF PLASTIC COLLAPSE AND THEIR APPLICATIONS 10

Perfect plastic material- theory of plasticity – Hardening law, flow rule. Theorem of plastic collapse – bound theorems – Mechanism for plane plastic collapse – slip fans, stress fans – discontinuities – Simple solutions for undrained and drained loading – Stability of foundations, retaining walls, slopes and cuts.

UNIT IV STABILITY OF SOIL STRUCTURE BY SLIP LINE METHOD AND LIMIT EQUILIBRIUM ANALYSIS 14

Introduction – stress – strain relationship in a perfectly plastic material – discontinuous slipping – stress and displacement field calculations – associated field calculation – Slip line solutions for undrained and drained conditions – limit equilibrium solutions for stability of foundation, retaining walls and slopes.

UNIT V FLOW THROUGH POROUS MEDIA 10

Flow through porous media – Darcy's law – General equation of flow, seepage through isotropic anisotropic and non-homogeneous conditions – Steady state condition, confined and unconfined flow – solution by flow net – seepage pressure – piping.

TOTAL : 60 PERIODS

OUTCOME:

At the end of the course students will have the capacity to estimate the stresses in soil medium of any type due to foundation load and settlement of foundation. Further they will be in a position to evaluate bound and true collapse loads of soil structures.

REFERENCES:

1. Aysen, A., "Problem solving in Soil Mechanics", Taylor & Francis, London, First Indian Print, 2011.
2. Chowdhury, I., Dasgupta S.P., "Dynamics of Structure and Foundations", Taylor & Francis Group, London, 2009.
3. Bolton, M.D; A Guide to Soil Mechanics, University press (India) Pvt.Ltd., 2009
4. Atkinson, J.H; "The Mechanics of Soils and Foundations", Taylor and Francis, London, 2007.
5. Aysen, A., "Soil Mechanics, Basic concepts and Engineering Applications", A.A.Balkema Publishers, 2002.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

HARD CORE ELECTIVE III

22255E25A DESIGN OF SUB STRUCTURE L T P C

3 0 0 3

OBJECTIVES:

- To gain familiarity with different types of foundation.
- To expose the students to the design of shallow foundations and deep foundations.
- To understand the concepts of designing well, machine and special foundations.

UNIT I SHALLOW FOUNDATIONS 9

Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.

UNIT II PILE FOUNDATIONS 9

Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles –configuration of piles- different shapes of piles cap – structural design of pile cap.

UNIT III WELL FOUNDATIONS 9

Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.

UNIT IV MACHINE FOUNDATIONS 9

Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.

UNIT V SPECIAL FOUNDATIONS 9

Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls.

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of this course students will be able to select appropriate foundation typebased on available soil conditions.
- They will be in a position to determine the load carrying capacity of each type offoundation.
- They will gain thorough knowledge about the design of reinforced concrete shallowfoundations, pile foundations, well foundations.

REFERENCES:

1. Bowles .J.E., "Foundation Analysis and Design", McGraw Hill Publishing co., New York,1997.
2. Swamy Saran, Analysis and Design of substructures, Oxford and IBH Publishing Co. Pvt.Ltd., 2006.
3. Tomlinson.M.J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi,1995.
4. Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited,New Delhi – 2009.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E25B ADVANCED FOUNDATION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

To design various types of foundations to fulfill the required criteria.

UNIT I SHALLOW FOUNDATIONS 9

soil investigation – Types of foundations and their specific applications – depth of foundation – bearing capacity and settlement estimates – structural design of isolated, strip, rectangular and trapezoidal and combined footings – strap – raft foundation.

UNIT II PILE FOUNDATIONS 9

Types of Pile foundations and their applications – Load Carrying capacity – pile load test – Settlements – Group action – pile cap – structural design of piles and pile caps – undreamed pile foundation.

UNIT III WELL FOUNDATION 9

Types of well foundations – grip length – load carrying capacity – construction of wells – failure and remedies – structural design of well foundation – lateral stability.

UNIT IV MACHINE FOUNDATIONS 9

Types – General requirements and design criteria – General analysis of machine foundations-soil system – Stiffness and damping parameters – Tests for design parameters – design of foundation for reciprocating engines, impact type machines and rotary type machines.

UNIT V SPECIAL FOUNDATIONS 9

General requirements and design criteria – Foundations for towers, Chimneys and Silos – design of anchors

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course student will be able to

CO1 Design shallow and deep foundations for various types of structures

CO2 Design piles and pile caps

CO3 Design well foundation for bridge piers and related structures

CO4 Gain knowledge on design and construction of machine foundation

CO5 Design foundations for bridges, towers and chimneys

REFERENCES:

1. Tomlinson, M.J. and Boorman. R., Foundation Design and Construction, ELBS Longman, Seventh Edition, 2001.

2. Nayak, N.V., Foundation Design manual for Practicing Engineers, Dhanpat Rai and Sons, 2018.

3. Brain J. Bell and M.J. Smith, Reinforced Concrete Foundations, George Godwin Ltd., 1981.

4. Braja M. Das, Principles of Foundations Engineering, Eighth Edition, Thomson Asia (P) Ltd., 2017.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	3	2	2	2
2	2	1	-	2	3	2
3	3	2	2	2	2	2
4	2	-	1	1	2	2
5	2	2	1	1	2	3
Avg	2.4	1.75	1.75	1.60	2.20	2.20

22255E25C ELEMENTS OF EARTHQUAKE ENGINEERING L T P C
3 1 0 4

AIM AND OBJECTIVES:

This course covers the theory and applications related to Earthquake Engineering. The broad subjects discussed in this course include earthquake response of linearly elastic and inelastic buildings, structural dynamics in building codes.

UNIT I ELEMENTS AND FEATURES 12

Elements of Seismology - Definitions of magnitude – Intensity - Epicentre etc - General features of tectonics of seismic regions - Seismographs.

UNIT II THEORY OF VIBRATIONS 12

Theory of Vibrations - Free vibrations of single degree - Two degree and multiple degree freedom systems - Computations of dynamic response to time dependent forces - Vibrations isolation – Vibration absorbers - Brief introduction to instruments - Accelerograms.

UNIT III PRINCIPLES OF EARTHQUAKE DESIGN 12

Principles of earthquake resistant design - Response spectrum theory - Application of response spectrum theory to seismic design of structures. Capacity - Design Principles - Design criteria for strength - Stiffness and ductility.

UNIT IV EARTHQUAKE ANALYSIS 12

Earthquake Analysis and Design - Characteristics of earthquake – Earthquake response of structures – Concept of earthquake resistance design – Code provisions for design of building – IS 1893 and IS 4326 – Energy absorption capacity.

UNIT V COMPUTER APPLICATION 12

Seismic analysis and design of a multi storied building using Computer.

TOTAL: 60 PERIODS

REFERENCE

1.Pauley & Priestly, (1992), Seismic design of reinforced concrete and masonry buildings, John Wiley & Sons.
2.Stratta.J.L, (1998), Manual of Seismic Design, Prentice-Hall India Pvt Ltd.
3.Kramer.S.L., (2002), Geotechnical Earthquake Engineering, Prentice-Hall India Pvt Ltd.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E25D DEVELOPMENT & APPLICATIONS OF SPECIAL CONCRETE

L	T	P	C
3	1	0	4

OBJECTIVE:

To study the development & applications of special concrete.

UNIT I INTRODUCTION **9**

General Consideration – Distresses monitoring – Causes of distresses – Quality assurance – Defects due to climate, chemicals, wear and erosion – Inspection – Structural appraisal – Economic appraisal.

UNIT II BUILDING CRACKS **9**

Causes – diagnosis – Thermal and Shrinkage cracks – unequal loading – Vegetation and trees – Chemical action – Foundation movements – Remedial measures - Techniques for repair – Epoxy injection.

UNIT III MOISTURE PENETRATION **9**

Sources of dampness – Moisture movement from ground – Reasons for ineffective DPC – Roof leakage – Pitched roofs – Madras Terrace roofs – Membrane treated roofs - Leakage of Concrete slabs – Dampness in solid walls – condensation – hygroscopic salts – remedial treatments – Ferro cement overlay – Chemical coatings – Flexible and rigid coatings.

UNIT IV DISTRESSES AND REMEDIES **9**

Concrete Structures: Introduction – Causes of deterioration – Diagnosis of causes – Flow charts for diagnosis – Materials and methods of repair – repairing, spalling and disintegration – Repairing of concrete floors and pavements. Steel Structures : Types and causes for deterioration – preventive measures – Repair procedure – Brittle fracture – Lamellar tearing – Defects in welded joints – Mechanism of corrosion – Design of protect against corrosion – Design and fabrication errors – Distress during erection. Masonry Structures: Discoloration and weakening of stones – Biotical treatments – Preservation – Chemical preservatives – Brick masonry structures – Distresses and remedial measures.

UNIT V STRENGTHENING OF EXISTING STRUCTURES **9**

General principle – relieving loads – Strengthening super structures – plating – Conversation to composite construction – post stressing – Jacketing – bonded overlays – Reinforcement addition – strengthening substructures – under pinning – Enhancing the load capacity of footing – Design for rehabilitation.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course students will be in a position to point out the causes of distress concrete, masonry and steel structures and also they will be able to suggest the remedial measures.

REFERENCES:

1. Allen R.T and Edwards S.C, “Repair of Concrete Structures”, Blakie and Sons, UK, 1987

2. Dayaratnam.P and Rao.R, “Maintenance and Durability of Concrete Structures”, University Press, India, 1997.

3. Denison Campbell, Allen and Harold Roper, “Concrete Structures, Materials, Maintenance and Repair”, Longman Scientific and Technical, UK, 1991.

4. Dodge Woodson.R,”Concrete Structures – protection, repair and rehabilitation”, Elsevier Butterworth – Heinmann, UK, 2009.

5. Hand book on seismic retrofit of Building by CPWD and IIT Madras,2003.

6. Peter H.Emmons, “Concrete Repair and Maintenance Illustrated”, Galgotia Publications Pvt. Ltd., 2001.

7. Raikar, R.N., “Learning from failures - Deficiencies in Design, Construction and Service” – Rand D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.

COs - PO’s & PSO’s MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	-	-	2	2	1
2	3	1	2	2	2	2
3	3	2	3	2	2	3
4	3	-	-	2	3	2
5	2	2	2	2	3	2
Avg	2.8	1.67	2.33	2	3	2

22255E25E VIBRATION OF CONTINUOUS SYSTEMS L T P C
3 1 0 4

COURSE OBJECTIVES

1. To appreciate the basic concepts of vibration in damped and undamped systems
2. To calculate the natural frequencies and mode shapes of the two degree freedom systems
3. To determine the natural frequencies and mode shapes of the multi degree freedom and continuous systems
4. To learn the fundamentals of control techniques of vibration and noise levels
5. To use the instruments for the measuring and analyzing the vibration levels in a body

UNIT - I FUNDAMENTALS OF VIBRATION 9+3

Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and AccelerationReview Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response To Arbitrary and non- harmonic Excitations – Transient Vibration –Impulse loadsCritical Speed Of Shaft-Rotor systems

UNIT-II TWO DEGREE FREEDOM SYSTEM 9+3

Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates.

UNIT-III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9+3

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients-Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method -Geared Systems-Eigen Values & Eigenvectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams

UNIT-IV VIBRATION AND NOISE CONTROL 9+3

Specification of Vibration Limits – Vibration severity standards- Vibration as condition Monitoring Tool-Vibration Isolation methods - Dynamic Vibration Absorber - Static and Dynamic Balancing machines – Field balancing - Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver.

UNIT-V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 9+3

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. - Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –

Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes

TOTAL : 60 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

CO1 Apply the basic concepts of vibration in damped and undamped systems

CO2 Determine the natural frequencies and mode shapes of the two degree freedom systems.

CO3 Calculate the natural frequencies and mode shapes of the multi degree freedom and continuous systems

CO4 Control the vibration and noise levels in a body

CO5 Measure and analyze the vibration levels in a body

REFERENCES:

1. Graham Kelly, Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw – Hill Publishing Com. Ltd., 2007

2. Singiresu S. Rao, ”Mechanical Vibrations, ”Pearson Education Incorporated, 2017

3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2010 4. WilliamT. Thomson, “Theory of Vibration with Applications”, Taylor & Francis,2018

COs - PO’s & PSO’s MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	-	2	3	2	2
2	3	1	-	2	2	1
3	3	-	2	2	3	1
4	3	1	-	3	2	2
5	3	2	1	2	2	1
Avg	3	1.33	1.67	2.40	2.20	1.40

SEMESTER III

HARD CORE ELECTIVE IV

22255E32A OPTIMIZATION IN STRUCTURES L T P C

3 1 0 4

AIM AND OBJECTIVES:

The structural analysis is formulated through the principle of optimization. Both the manual calculation and application of the computer are introduced for the analysis of truss and frame structures using optimization techniques.

UNIT I INTRODUCTION 12

Basic concepts of minimum weight, minimum cost design, Objective function, constraints and classical methods.

UNIT II OPTIMIZATION TECHNIQUES 12

Linear programming, Integer Programming, Quadratic Programming.

UNIT III ALGORITHMS 12

Dynamic Programming and Geometric Programming methods for Optimal design of structural elements.

UNIT IV COMPUTER SEARCH METHODS 12

Linear Programming methods for plastic design of frames, Computer search methods for univariate and multivariate Minimization.

UNIT V OPTIMIZATION BY STRUCTURAL THEOREMS 12

Maxwell, Mitchell and Heyman's Theorems for trusses and frames, fully stresses design with deflection constraints, optimality criterion methods.

TOTAL: 60 PERIODS

REFERENCES

1. Spunt, Optimum Structural Design, Civil Engineering and Engineering Mechanics Services,Prentice-Hall, New Jersey 1971.

2. S.S.Rao, Optimization Theory and Applications, Wiley Eastern Limited, New Delhi, 1977.

3. Uri Krisch, Optimum Structural Design, McGraw Hill Book Co. 1981.

4. Richard Bronson, Operation Research, Schaum's Outline Series, McGraw Hill Book Co, Singapore, 1983.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E32B WIND AND CYCLONE EFFECTS ON STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

- To study the concept of wind and cyclone effects for the analysis and design of structures.

UNIT I INTRODUCTION 9

Introduction, Types of wind – Characteristics of wind – Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects - Dynamic nature of wind – Pressure and suctions - Spectral studies, Gust factor.

UNIT II WIND TUNNEL STUDIES 9

Wind Tunnel Studies, Types of tunnels, - Prediction of acceleration – Load combination factors – Wind tunnel data analysis – Calculation of Period and damping value for wind design - Modeling requirements, Aero dynamic and Aero-elastic models.

UNIT III EFFECT OF WIND ON STRUCTURES 9

Classification of structures – Rigid and Flexible – Effect of wind on structures - Static and dynamic effects on Tall buildings – Chimneys.

UNIT IV DESIGN OF SPECIAL STRUCTURES 9

Design of Structures for wind loading – as per IS, ASCE and NBC code provisions – design of Tall Buildings – Chimneys – Transmission towers and steel monopoles– Industrial sheds.

UNIT V CYCLONE EFFECTS 9

Cyclone effect on – low rise structures – sloped roof structures - Tall buildings. Effect of cyclone on claddings – design of cladding – use of code provisions in cladding design – Analytical procedure and modeling of cladding.

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of this course, students will be able to design high rise structures subjectedwind load, even structures exposed to cyclone.
- Students will be conversant with various code provisions for the design of structures forwind load.

REFERENCES:

1. Cook.N.J., "The Designer's Guide to Wind Loading of Building Structures", Butterworths,1989.
2. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, "Wind Effects on Civil EngineeringStructures", Elsevier Publications, 1984
3. Lawson T.V., "Wind Effects on Building Vol. I and II", Applied Science Publishers, London, 1980.Peter Sachs, "Wind Forces in Engineering", Pergamon Press, New York, 1978

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	-	-	3	1	1
2	3	2	2	2	2	2
3	2	3	2	2	3	2
4	3	-	1	2	2	2
5	3	2	2	2	3	2
Avg	2.8	2.33	1.75	2.20	2.20	1.80

22255E32C A SEISMIC DESIGN OF STRUCTURES L T P C
3 1 0 4

AIMS AND OBJECTIVES:

This course deals about seismology, seismic design concepts, codal provisions and detailing of frames.

UNIT I INTRODUCTION 12

Elements of Engineering Seismology - Theory of Vibration - Response Spectrum.

UNIT II HISTORICAL 12

Indian Seismicity - Earthquake History - Behaviour of Structures in the past Earthquakes.

UNIT III DESIGN CONCEPTS 12

Seismic Design Concepts - Cyclic load behaviour of RC, Steel and Prestressed Concrete elements – Design spectrum - Principles of capacity design.

UNIT IV CODAL PROVISIONS 12

Provisions of Seismic Code (IS 1893) - Building systems frames, shear walls, Braced Frames, Combinations - Torsion.

UNIT V DESIGN AND DETAILING 12

Performance of Regular Buildings 3 D Computer Analysis of Building Systems (Theory Only) - Design and Detailing of frames - Shear walls and Frame walls.

TOTAL: 60 PERIODS

REFERENCES:

1. Course Notes "Design of Reinforced Concrete Building", IIT, Kanpur, June 1999.
2. Bungale S.Taranath "Structural Analysis and Design of Tall Buildings" McGraw Hill Book Company, New York, 1999.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	-	-	3	2	1
2	3	2	2	2	2	1
3	2	2	1	2	2	1
4	2	2	2	2	2	2
5	3	-	-	3	2	2
Avg	**2.6**	**2**	**1.67**	**2.40**	**2**	**1.40**

22255E32D URBAN TRANSPORTATION SYSTEM PLANING

L	T	P	C
3	1	0	4

OBJECTIVE:

To impart knowledge in the rudiments and advancements in Transportation Planning and Travel Demand Forecasting

UNIT I TRANSPORTATION SYSTEM STATUS 9

Status of existing Transportation System – Systems Approach to Transport Planning - Interdependence of the Landuse and Traffic – Stages in Transportation Planning – Transport Systems and Planning Considerations. Concepts of Zoning – O-D Surveys – Inventory of Transport and other activities – TravelForecasting Process - Forecasting Process - Critical issues in Travel forecasting – Basics of Systems Simulation Modeling.

UNIT II TRIP GENERATION AND DISTRIBUTION 9

Trip Generation Models-Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models, Gravity model and Opportunity modes

UNIT III MODAL SPLIT 9

Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models - Utility functions - Logit models - Two stage model.

UNIT IV TRAFFIC ASSIGNMENT 9

Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior.

UNIT V LAND USE TRANSPORT MODEL (LUT) 9

Accessibility Measures and Basic Theories – Lowry Derivatives Model- Garin Model –Approach and Simulation Modeling in LUT Model - Multimodal Transportation Planning.

TOTAL: 45 PERIODS

OUTCOMES:

Students would be aware of the Principles and Planning of Transportation Infrastructure.

REFERENCES:

1. Konstadinos G. Goulias „Transportation Systems Planning: Methods and Applications“ CRC Press, Taylors and Frances Group.
2. Ennio Cascetta „Transportation Systems Analysis: Models and Applications“ 2nd Edition, Springer New York.
3. John Khisty C, Kent Lall B, "Transportation Engineering – An Introduction, 3rd Edition, Prentice Hall of India, New Delhi, 2002
4. Papacostas C.S., Prevedouros, "Transportation Engineering and Planning, 3rd Edition, Prentice Hall of India, New Delhi, 2002
5. John D.Edwards (Edr.), "Transportation Planning Hand Book", 2nd Edition, Institute of Transportation Engineers, Prentice Hall Inc.,, Washington DC, USA, 1999

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	-	-	3	2	2
2	3	2	2	3	3	2
3	3	2	2	2	3	3
4	3	2	2	3	2	3
5	3	2	2	2	3	3
Avg	3	2	2	2.6	2.60	2.60

22255E32E APPLIED SEISMOLOGY FOR ENGINEERS L T P C
3 1 0 4

AIMS &OBJECTIVES:

Provide the students with an introduction of seismology and advanced level understanding of the

- Mechanisms of earthquakes and measurement of strong ground motions Enable the students to conduct ground response analysis
- Provide the students with advanced level understanding of dynamic soil properties and soil-structure
- interaction Enable the students to perform seismic slope stability analysis/design

UNIT-I INTRODUCTION TO THE HAZARDS OF EARTHQUAKES 9

strong ground motions, tsunamis, landslides, liquefaction. Review of plate tectonics. Seismic hazard in Puerto Rico and beyond; Maths review: Fourier Transforms Single degree of freedom dynamics, damped vibrations. Convolutions, Green's Functions; A seismic station: sensors and data loggers. Poles and zeros for sensor response; Mechanical and digital sensor design and performance

UNIT-II INTERPRETATION OF SEISMIC RECORDS 9

Acceleration, velocity and displacement; Issues with strong ground motions and record parameterisation; Theory of wave propagation: Body waves Theory of wave propagation: Surface waves

UNIT-III DYNAMIC SOIL PROPERTIES 9

Stress & strain conditions, concept of stress path; Measurement of seismic response of soil at low and high strain, using laboratory tests; Cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge and using field tests - standard penetration test, dynamic plate load test, block vibration test, SASW/MASW tests, cross bore hole; Evaluation of damping and elastic coefficients; Stress-strain behavior of cyclically loaded soils; Effect of strain level on the dynamic soil properties; Equivalent linear and cyclic nonlinear models; Static and dynamic characteristics of soils.

UNIT-IV BACKGROUND AND LESSONS LEARNT FROM DAMAGES IN PAST EARTHQUAKE 9

Wave in infinite & semi-infinite media –one, two and three dimensional wave propagation; Attenuation of stress waves – material and radiation damping; Dispersion, wave in a layered media; Determination of Dynamic Soil Properties as per IS-5249; Ground Response Analysis: Introduction one, two and three dimensional analyses; Introduction to soil-structure interaction

UNIT-V EVALUATION OF LIQUEFACTION POTENTIAL 9

characterization of earthquake loading and liquefaction resistance, cycle stress ratio, Seed and Idress method; Effects liquefaction; Seismic design of retaining walls: types, modes of failure, static pressure, seismic response (including M-O method), seismic displacement, design consideration; Types of earthquake induced landslides; Evaluation of slope stability: stability analysis with dynamic loading, friction circle method, effective and total stress methods of analysis, yield acceleration, damage

potential, displacement analysis, effect of saturated and submerged conditions, FEM analysis of slope stability

TOTAL: 45 PERIODS

TEXT BOOKS

1. International Handbook of Earthquake and Engineering Seismology. Lee, W.H.K, Kanamori, H
2. Jennings, P.C., Kissinger, C., Academic Press Introduction to Seismology. Shearer, P. M., Cambridge University Press
3. Geotechnical Earthquake Engineering. Kramer, S. L., Prentice Hall
4. Soil Dynamics, Prakash, S., McGraw Hill Book Company.

REFERENCE BOOKS

1. An Introduction to Seismology, Earthquakes and Earth Structure. Stein, S. and Wysession, M.,
2. Blackwell Publishing Modern Global Seismology. Lay, T., and Wallace, T. C., Academic Press
3. Geotechnical Earthquake Engineering Handbook, Day Robert, W., McGraw-Hill

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	2
2	3	3	2	2	3	2
3	3	2	2	3	3	3
4	3	2	2	3	2	2
5	3	2	2	2	3	2
Avg	3	2.2	2	2.60	2.60	2.20

HARD CORE ELECTIVE V

22255E33A PREFABRICATED STRUCTURES L T P C
3 1 0 4

AIMS &OBJECTIVES:

This course explains about design principles of Prefabricated Structures, components, application of prefabricated structures. Students can learn the usage of prefabricated structures in wall panels, industrial buildings and shell roofs.

UNIT I DESIGN PRINCIPLES 12

General Civil Engineering requirements- IS Code specifications. Modular co-ordination, standardization- Disuniting of Prefabricates, production, transportation, and erection-Safety factors, material properties, Deflection control.

UNITII REINFORCED CONCRETE 12

Prefabricated structures - Long wall and cross-wall large panel buildings- One way and two way prefabricated slabs- Framed buildings with partial and curtain walls- Connections – Beam to column and column to column

UNIT III FLOORS, STAIRS AND ROOFS 12

Types of floor slabs, analysis and design example of cored and panel - Staircase slab design, types of roof slabs and insulation requirements- Description of joints, their behavior and reinforcement requirements- Ultimate strength calculations in shear and flexure

UNIT IV WALL 12

Types of wall panels, Blocks and large panels, Curtain- Partition and load bearing walls, load transfer from floor to wall panels- Design Curves, types of wall joints, their Behaviour and design -Leak prevention, joint sealants, sandwich wall panels

UNIT V INDUSTRIAL BUILDINGS AND SHELL ROOFS 12

Components of single-storey industrial sheds with crane gantry systems- R.C. Roof Trusses, Roof Panels, corbels and columns- Cylindrical, Folded plate and hypar-prefabricated shells-Erection and jointing, joint design, hand book based design

TOTAL: 60 PERIODS

REFERENCE BOOKS

1. Murashev.V., Sigalov.E., and Bailov.V., Design of Reinforced Concrete Structures, Mir Publishers

2. Gerostiza. C.Z., Hendrikson, C. and Rehat D.R., Knowledge Based Process Planning for Construction and Manufacturing, Academic Press, Inc

3. Hass, A.M. Precast Concrete Design and Applications, Applied Science Publishers, 1983.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	2	2
2	3	3	3	2	3	3
3	3	3	3	2	3	2
4	3	-	1	3	2	2
5	3	2	2	2	2	2
Avg	3	2.5	2.2	2.4	2.4	2.2

22255E33B **DESIGN OF BRIDGES** **L T P C**
3 0 0 3

OBJECTIVE:

- To study the loads, forces on bridges and design of several types of bridges.

UNIT I GENERAL INTRODUCTION AND SHORT SPAN RC BRIDGES 9

Types of bridges and loading standards - Choice of type - I.R.C. specifications for road bridges – Design of RCC solid slab bridges - analysis and design of slab culverts , Tee beam and slab bridges.

UNIT II LONG SPAN RC BRIDGES 9

Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts – Segmental bridges.

UNIT III PRESTRESSED CONCRETE BRIDGES 9

Flexural and torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – Diaphragms – End block – short term and long term deflections.

UNIT IV STEEL BRIDGES 9

General – Railway loadings – dynamic effect – Railway culvert with steel beams – Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

UNIT V BEARINGS AND SUBSTRUCTURES 9

Different types of bearings – Design of bearings – Design of piers and abutments of different types - Types of bridge foundations – Design of foundations.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course students will be able to design different types of RCC bridges, Steel bridges and pre-stressed concrete bridges with the bearings and substructures.

REFERENCES:

1. Jagadeesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hall of IndiaPvt. Ltd. 2004.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. NewDelhi, 2001.
3. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, 2008.
4. Raina V.K." Concrete Bridge Practice" Tata McGraw Hill Publishing Company, New Delhi,1991.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E33C SURFACE WATER HYDROLOGY L T P C
3 0 0 3

OBJECTIVE:

This subject aims at making the students to understand the relevance of various components of hydrologic cycle, which are responsible for spatial and temporal distribution of water availability in any region.

UNIT I HYDROMETEOROLOGY 9

Hydrologic cycle – Global water budget – Practical applications – Hydrometeorology – Constituents of atmosphere – Vertical structure of the atmosphere – general circulation – Transitory system – Air mass – Air front – cyclones – Formation of precipitation – Types and forms of precipitation – Climate and Weather – Meteorological Observations.

UNIT II PRECIPITATION 8

Measurement of rainfall – Rain gauges – Radar Measurement of rainfall - Rainfall Hyetograph – Intensity Duration and Frequency analysis – Consistency – Missing data – Rain gauge network – Average depth of rainfall analysis – Spatial analysis using GIS – Annual rainfall of India and Tamilnadu

UNIT III ABSTRACTIONS 8

Water losses - Initial losses – Interception and depression storage – Evaporation – Evaporimeters – Estimation of Evaporation - Evapotranspiration – Field Measurement – Empirical Equations - Infiltration – Infiltrometers – Infiltration Equations - Infiltration Indices.

UNIT IV STREAMFLOW MEASUREMENT 8

Stage and Velocity Measurement – Gauges – Current meter and Doppler flow velocity meter - Discharge measurement – Area Velocity method - Area Slope method – Discharge Measuring Structures - Dilution Technique – Stage Discharge relationship – Selection of a Stream Gauging Site. .

UNIT V RUNOFF AND WATER CONSERVATION 12

Concept of catchment – Linear, Areal and Relief Aspects – Detailed study of Runoff process – Factors affecting Runoff – Hydrograph – Unit Hydrograph – Synthetic Hydrograph –Runoff estimation - Strange and SCS methods – Water Conservation – Rain water and Runoff Harvesting in Rural and Urban Areas - Reservoir Sedimentation.

TOTAL: 45 PERIODS

OUTCOMES:

The students obtain the complete knowledge on hydrologic cycle, hydrometeorology and

- Formation of precipitation.

The students are able to apply the various methods of field measurements and empirical

- Formulas for estimating the various losses of precipitation, stream flow and runoff.

The students know the various methods of rainwater and runoff harvesting.

Then apply the knowledge of soil erosion and sedimentation to estimate the life of

the reservoir.

REFERENCES:

1. Chow V.T., Maidment D.R., Mays L.W., "Applied Hydrology", McGraw Hill Publications, New York, 1995.
2. Subramanya K., "Hydrology,Tata McGraw Hill Co., New Delhi, 1994.
3. Patra.K.C, "Hydrology and Water Resources Engineering", Narosa Publications, 2008, 2 nd Edition, New Delhi.
4. Jeya Rami Reddy.P, "Hydrology, Laximi Publications, New Delhi, 2004

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E33D UNSATURATED SOIL MECHANICS L T P C
3 0 0 3

OBJECTIVES:

To impart knowledge in assessing both physical and engineering behaviour of unsaturated soils, measurement and modeling of suction – water content and suction – hydraulic conductivity of unsaturated soils.

UNIT I STATE OF UNSATURATED SOIL 6

Definition – Interdisciplinary nature of unsaturated soil – soil classification – Nature and practice – stress profiles, stress state variables - material variables – constitutive law – suction potential of soil water

UNIT II PHYSICS OF SOIL WATER SYSTEM 9

Physical properties of Air and water – partial pressure and relative Humidity Density of moist air – surface Tension – cavitations of water. Solubility of Air in water – Air – water solid interface – vapor pressure lowering – soil water characteristic-curve. Capillary tube model – contacting sphere model. Young Laplace equation – Height of capillary rise – Rate of capillary rise – capillary pore size distribution – theoretical basis – determination – laboratory method.

UNIT III STRESS STATE VARIABLES AND SHEAR STRENGTH 12

Effective-stress – stress between two spherical particles – Hysteresis in SWCC – stress parameter, stress tensor – stress control by Axis Translation - analytical representation of stress – volume change characteristics. Extended Mohr – Coulomb criterion – shear strength parameters – Interpretation of Direct shear test results and Tri axial test results – unified representation of failure envelope – Influence of suction in earth pressure distribution.

UNIT IV STEADY AND TRANSIENT FLOWS 9

Driving mechanism – Permeability and Hydraulic conductivity – capillary barriers – steady infiltration and evaporation – Vapor flow – Air diffusion in water. Principles for pore liquid flow – Rate of infiltration, Transient suction and moisture profiles. Principles for Pore Gas flow – Barometric pumping Analysis.

UNIT V MATERIAL VARIABLE MEASUREMENT AND MODELLING 9

Measurement of total suction – psychrometers – Filter paper measurement of matric suction – High Air Entry disks – Direct measurements – Tensiometers – Air-translation technique – Indirect measurements – Thermal conductivity sensors – measurement of osmotic suction – squeezing technique – soil water characteristic curves and Hydraulic conductivity models.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to•

CO1 Explain stress state variables, material variables and constitutive law of unsaturated soil

CO2 Explain the physics of soil-water mechanism, relationship of models.

CO3 Explain and determine the soil-water characteristic curve and the shear strength of unsaturated soil

CO4 Explain the principles of vapour flow, air diffusion, pore liquid flow and rate

of infiltration in unsaturated soil.

CO5 Measure the material variables and select the suitable soil models.

REFERENCES:

1. Fredlund, D.G., Rahardjo, H. and Fredlund, M.D., Unsaturated Soil Mechanics in Engineering Practice, John Wiley & Sons, INC, New Jersey, 2012.

2. Ning Lu and William, J. Likes, Unsaturated Soil Mechanics, John Wiley & sons, INC. New Jersey, 2004

3. Ng Charles, W.W., Menzies Bruce, Advanced unsaturated Soil Mechanism and Engineering, Taylor & Francis Group, 2007.

4. Ning Lu, Laureano R. Hoyes and Lakshmi Reddi, Advances in unsaturated soil, seepage and Environmental Geotechnics, ASCE., Geotechnical special publication No.148.

5. Jean- Louis Briaud., Geotechnical Engineering: Unsaturated and Saturated soils, John Wiley & Sons, INC, New Jersey, 2013.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E33E REMOTE SENSING & GIS FOR RURAL DEVELOPMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

Expose the students with concepts of cartography as major components of input and output

- Related to cartography. To provide exposure to data models and data structures in GIS and to introduce various
- Raster and Vector Analysis capabilities. To expose the concept of quality and design of cartographic outputs in open GIS

UNIT I CARTOGRAPHY **9**

Definition of Map - Mapping Organsiation in India- Classification based on Function, Scale, Characteristics – Ellipsoid and Geoid – Co-ordinate Systems - Rectangular and Geographic Coordinates – UTM and UPS - Projection – Function - Types of Map Projections – Transformations – Function - Affine transformation - Choice of Map Projection – Evolution of cartography- GeoSpatial, Spatial and Non-spatial data – Definition of GIS – Evolution GIS – Components of GIS – Digital Cartography concepts. - 3D GIS.

UNIT II GIS DATA MODELS AND DATA INPUT **9**

Point, Line Polygon / Area, elevation and surface –Tessellations - Attributes and Levels of Measurement - Data Sources – Ground and Remote Sensing survey – Collateral data collection – Input: Map scanning and digitization, Registration and Georeferencing – Concepts of RDBMS Raster Data Model – Grid – Data Encoding - Data Compression – Vector Data Model – Topological properties – Arc Node Data Structure – Raster Vs. Vector Comparison – File Formats for Raster and Vector – Data conversion between Raster and vector.

UNIT III RASTER AND VECTOR DATA ANALYSIS **9**

Raster Data analysis: Local, Neighborhood and Regional Operations – Map Algebra – Vector Data Analysis: Topological Analysis, point-in-polygon, Line-in-polygon, Polygon-in-Polygon – Proximity Analysis: buffering, Thiessen Polygon – Non-topological analysis: Attribute data Analysis- concepts of SQL– ODBC

UNIT IV NETWORK ANALYSIS AND SURFACE ANALYSIS 9 Network – Creating Network Data - Origin, Destination, Stops, Barriers – Closest Facility Analysis, Service Area Analysis, OD Cost matrix analysis, Shortest Path Analysis – Address Geocoding – Surface Analysis – DEM, DTM - Point data to Surface interpolation – DEM Representaiton – Applications

UNIT V DATA OUTPUT AND WEB BASED GIS **9**

Map Compilation – Cartographic functionalities for Map Design – Symbolization – Conventional signs and symbols – Spatial Data Quality – Lineage, Positional Accuracy, Attribute Accuracy, Completeness, Logical Consistency - Meta Data – Web based GIS Merits - Architecture – Map Server – Spatial Data Infrastructure – Spatial Data Standards – OGC Standards - Free and Open Source – Proprietary - GIS Software .

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the Characteristics and Components of Maps and GIS

CO2 Perform input of Spatial and Non-spatial data into GIS

CO3 Analyse Spatial Relationship between Elements using GIS tools

CO4 Evaluate Network and Surface Data for Decision Making

CO5 Present the Spatial Information and Access the Quality against Standards

REFERENCES:

1. Kang-tsung Chang, Introduction to Geographic Information Systems: 9th Edition, 9781259929649, McGraw-Hill Education, 2018

2. Lo, C.P. and Yeung, Albert K.W., Concepts and Techniques of Geographic Information Systems, Pearson, 2018, 9th edition.

3. Ian Heywood, Sarah Cornelius, Steve Carver, An Introduction to Geographical Information Systems, Pearson Education, 4th Edition, 2011.

4. Michael N. DeMers, Fundamentals of geographic information systems, Wiley, 2012, 4th edition

5. Borden D Dent, Jeff Torguson, Thomas W. Hodler, Cartography: Thematic Map Design 6th Edition, ISBN-13: 978-0072943825 McGraw-Hill Education – Europe, 2008

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

HARD CORE ELECTIVE VI

22255E34A OFFSHORE STRUCTURES L T P C

3 1 0 4

AIMS & OBJECTIVES:

This course includes the details of wave theories, forces in offshore structures and design and analysis of offshore structures .

UNIT I WAVE THEORIES 12

Wave generation process, small and finite amplitude wave theories.

UNIT II FORCES OF OFFSHORE STRUCTURES 12

Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.

UNIT III OFFSHORE SOIL AND STRUCTURE MODELING 12

Different types of offshore structures, foundation modeling, and structural modeling.

UNIT IV ANALYSIS OF OFFSHORE STRUCTURES 12

Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT V DESIGN OF OFFSHORE STRUCTURES 12

Design of platforms, helipads, Jacket tower and mooring cables and pipe lines.

TOTAL: 60 PERIODS

REFERENCES:

1. Chakrabarti, S.K. Hydrodynamics of Offshore Structures, Computational Mechanics Publications, 1987.
2. Thomas H. Dawson, Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983
3. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex.
4. Wiegel, R.L., Oceanographical Engineering, Prentice Hall Inc, Englewood Cliffs, N.J. 1964.
5. Brebia, C.A.Walker, S., Dynamic Analysis of Offshore Structures, New-nes Butterworth's, U.K. 1979.
6. Reddy, D.V. and Arockiasamy, M., Offshore Structures, Vol.1, Krieger Publishing Company, Malabar, Florida, 1991.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E34B STRUCTURAL DYNAMICS L T P C
3 1 0 4

AIMS & OBJECTIVES:

This course deals with the concept and characteristics of stability problems and behavior of torsional buckling and lateral buckling in beams and columns.

UNIT I INTRODUCTION 12

Concept of stability approaches to stability analysis, characteristics of stability problems.

UNIT II COLUMNS 12

Buckling of columns with various end conditions, imperfect columns, elastically supported columns, non prismatic columns, Built-up columns, Inelastic buckling, Experimental study of column behavior, Empirical column formulae. Buckling of bars on elastic foundations, large deflection of buckled bars.

UNIT III BEAMS – COLUMNS 12

Beam-column theory, Application to buckling of frames.

UNIT IV TORSIONAL BUCKLING 12

Combined torsional and flexural buckling.

UNIT V LATERAL BUCKLING 12

Lateral buckling of beams, pure bending of simply supported beam and cantilever, numerical solutions.

TOTAL: 60 PERIODS

REFERENCES BOOKS:

1. Allen, H.G., and Bulson, P.S., Background to Buckling, McGraw Hill Book Company, 1980.
2. Smites, Elastic Stability of Structures, Prentice Hall, 1973.
3. Timoshenko, S., and Gere., Theory of Elastic Stability, McGraw Hill Book Company, 1961.
4. Brush and Almorth., Buckling of Bars, Plates and Shells, McGraw Hill Book Company, 1975.
5. Chajes, A. Principles of Structures Stability Theory, Prentice Hall, 1974.
6. Ashwini Kumar, Stability Theory of Structures, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1985.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E34C WATER SUPPLY ENGINEERING L T P C
3 1 0 4

OBJECTIVE:

To educate the students in detailed design concepts related to water transmission mains, water distribution system and buried pipes with emphasis on computer application

UNIT I WATER SUPPLY SYSTEMS 9

Water requirement – sources of water – water demand – reservoir storage – nodal hydraulic gradient level values - water supply consideration, Types of water supply systems- piping system- distribution network- labeling- network components – Network models – design – optimization in practice

UNIT II HYDRAULIC PRINCIPLES AND NETWORK PARAMETERS 10

Energy and hydraulic gradient lines – head loss in links – equivalent pipes – series – parallel pipes – path head loss and loop head loss – analysis of water distribution network- static node, dynamic node – network performance – flow analysis - Layout – in situ lining - pipes material – appurtenances – minimization of water losses – leak detection

UNIT III STORM WATER DISTRIBUTION AND BURIED PIPES 9

Planning – runoff estimation – rainfall data analysis – storm water drain design Introduction to Buried pipes – external loads – gravity flow design, pressurized flow- rigid and flexible pipes – installation – trenchless technology

UNIT IV RELIABILITY ASSESSMENT AND DESIGN 8

Uncertainty and reliability – affecting events- assessment – reliability parameters- configurations. Design methodology - strengthening and expansion

UNIT V FLUID TRANSIENTS 9

Basic equations of unsteady flows through closed conduits. Method of characteristics. Transients caused by centrifugal pumps and hydroelectric power plants.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be able to get a basic knowledge of the design of pipe networks.
- They will be able to analyze pipe network problems using computer software like EPANET2.0

REFERENCES:

1. Bhave P. R, Optimal design of water distribution networks, Narosa publishing House, New Delhi, 2003
2. Bajwa. G. S, Practical handbook on Public Health Engineering, Deep publishers, Shimla 2003
3. Manual on water supply and treatment, CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999
4. B.A. Hauser, practical hydraulics Hand Book, Lewis Publishers, New York, 1991
5. Moser A. P, Buried pipe Design, 3rd Edition, American Water Works Association

6. Robert van Bentum and Lan K. Smout, Buried Pipe lines for surface Irrigation, The Water, Engineering and Development Centre, Intermediate Technology Publications,UK,1994
7. Wurbs R.A., and James W.P. Water Resources Engineering. Prentice Hall of India, Eastern Economic Edition. ISBN: 81-203-2151-0, New Delhi, 2007

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E34D WATER AND WASTEWATER TREATMENT L T P C
3 1 0 4

OBJECTIVE:

To understand about the various pollutants present in water and wastewater and to choose

- The respective physico-chemical systems for effective treatment

To apply the knowledge for municipal, industrial water and wastewater treatment plants and

- Design suitable treatment schemes To gain advance knowledge on the emerging environmental issues on treatment systems and conduct research to identify most appropriate treatment schemes

UNIT I INTRODUCTION 5

Pollutants in water and wastewater–characteristics, standards for performance-significance of physico-chemical treatment–Selection criteria-types of reactor-reactor selection-batch-continuous type-kinetics

UNIT II TREATMENT PRINCIPLES 10

Physical treatment - screening – mixing, equalization –sedimentation – filtration – evaporation– incineration–gas transfer–mass transfer coefficient adsorption – isotherms – membrane separation, Reverse Osmosis, nanofiltration, ultrafiltration and electrodialysis, distillation– stripping and crystallization – recent advances. Principles of Chemical treatment– Coagulation - flocculation–Precipitation – flotation - solidification and stabilization–Disinfection, Ion exchange, Electrolytic methods, Solvent extraction–advanced oxidation/reduction– recent trends

UNIT III DESIGN OF MUNICIPAL WATER TREATMENT PLANTS 10

Selection of treatment–design of municipal water treatment plant units–aerators–chemical feeding– flocculation–clarifier–tube settling–filters–rapid sand filters, slow sand filter, pressure filter, dual media filter – disinfection flow charts– layouts – hydraulic profile ,PID-construction and O&M aspects– case studies, residue management – upgradation of existing plants – recent trends.

UNIT IV DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS 10

Design of industrial water treatment units-selection of process–design of softeners – demineralisers– Reverse osmosis plants–flow charts–layouts–hydraulic profile, PID-construction and O&M aspects– case studies, residue management–upgradation of existing plants –recent trends.

UNIT V DESIGN OF WASTEWATER TREATMENT PLANTS 10

Design of municipal wastewater treatment units-screens- grit chamber-settling tanks-sludge thickening - sludge dewatering systems - sludge drying beds - design of industrial wastewater treatment units - equalization - neutralization - chemical feeding devices – mixers - floatation units - oil skimmer - flowcharts – layouts – hydraulic profile, PID, construction and O&M aspects – case studies, retrofitting - residue management – upgradation of existing plants – recent trends.

TOTAL: 45 PERIODS

OUTCOME:

On Completion of the course, the student is expected to be able to

CO1 Explain the significance of various pollutants present in water, wastewater and develop the kinetics for reactor design

CO2 Choose the relevant physico-chemical systems for effective water and wastewater treatment

CO3 Design the treatment scheme for municipal and industrial water, wastewater to meet the specific needs on residue management and up gradation of existing plants

CO4 Identify environmental issues in the society on wastewater treatment and formulate technical solutions that are economically feasible and socially acceptable

CO5 Conduct research to identify and design most appropriate treatment schemes for the emerging environmental issues on treatment systems in collaboration with municipalities, corporation, pollution control boards and industries

REFERENCES:

1. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017

2. Lee, C.C. and Shun dar Lin, "Handbook of Environmental Engineering Calculations", McGraw Hill, New York, 1999.

3. Qasim.S.R., Guang Zhu., "Wastewater Treatment and Reuse" – Volume 1& 2 2018. 16

4. CPHEEO manual – "Manual for sewerage and sewage treatment systems" – Part A,B,C, Ministry of Urban development, New Delhi,2013.

5. CPHEEO manual – "Manual for water supply and treatment" –Ministry of Urban development, New Delhi, 1999.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	1	1	1	2	2	3
2	2	2	2	2	1	2
3	3	2	3	2	3	1
4	3	2	3	1	1	2
5	3	2	3	2	3	1
Avg	2.4	1.8	2.4	1.8	2	1.8

22255E34E APPLIED ENVIRONMENTAL MICROBIOLOGY L T P C
3 1 0 4

OBJECTIVES:

- To provide a basic understanding on microbiology relevant to environmental engineering for candidates.
- To gain knowledge on morphology, behaviour and biochemistry of bacteria, fungi, protozoa,viruses, and algae .
- To understand the microbiology of wastewater, sewage sludge and solid waste treatment processes.
- To understand the aspects of nutrient removal and the transmission of disease causing organisms.
- To have an exposure to toxicology due to industrial products and byproducts .

UNIT I FUNDAMENTALS OF MICROBIOLOGY 10

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, importance, introduction to water, soil and air borne pathogens and Parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, concentration and detection of virus. Control of microorganisms preservation of microorganisms, DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

UNIT II MICROBIAL DIVERSITY AND NUTRIENT TURNOVER 10

Distribution of microorganisms in different environments – diversity of microorganisms – fresh and marine, terrestrial – microbes in surface soil, air – outdoor and Indoor, aerosols, bio safety in laboratory – extreme environment – archae bacteria – occurrence in water supplies – problems and control. biogeochemical cycles-nitrogen, carbon, phosphorus, sulphur – Role of Microorganism in nutrient cycle.

UNIT III METABOLISM OF MICROORGANISMS 9

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics, disruption in metabolism and disease. biodegradation of organic pollutants

UNIT IV MICROBIOLOGY OF WASTEWATER TREATMENT SYSTEMS 8

Microbiology of biological treatment processes – aerobic and anaerobic, α-oxidation, β-oxidation, nitrification and denitrification, eutrophication. nutrients removal – BOD, nitrogen, phosphate. 14 microbiology of sewage sludge - indicator organisms of water – coliforms - total coliforms, E-coli, streptococcus, clostridium, Bioleaching

UNIT V TOXICOLOGY 8

Ecotoxicology – toxicants and toxicity, factors influencing toxicity. Effects – acute, chronic, test organisms – toxicity testing-lab and field testing methods, bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment and intellectual property rights.

CO2 Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.

CO3 Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes.

CO4 Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, and importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies.

CO5 Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

REFERENCES:

1. Bhatia S.C. "Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher, 2008

2. Gabriel Bitton, Wastewater Microbiology, 2nd Edition

3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press, 2000

4. Volodymyr Ivanov,Environmental Microbiology for Engineers 2nd Edition, CRC Press, 2015, ISBN 9781498702126

5. Nduka Okafor, Environmental Microbiology of Aquatic and Waste systems. Springer Publishers, 2011, ISBN 978-94-007-1459-5

6. Stanley E. Manahan, "Environmental Science and Technology", Lewis Publishers, 2008.

7. Hurst, C.J. Manual of "Environmental Microbiology". 2nd Ed. ASM PRESS, Washington, D.C. ISBN 1-55581 - 199 - X. 2002 8. Frank C. Lu and Sam Kacew, LU‟s Basic Toxicology, Taylor & Francis, London 4th Ed, 2002.

COs - PO's & PSO's MAPPING

CO	PO			PSO		
	1	**2**	**3**	**1**	**2**	**3**
1	3	2	2	3	3	2
2	3	2	-	3	2	2
3	2	-	-	2	2	2
4	2	2	2	2	2	2
5	3	3	3	2	2	2
Avg	2.6	2.25	2.33	2.20	2.20	2