Ph.D CIVIL ENGINEERING
CURRICULUM & SYLLABI
2022 -2023

Department of Civil Engineering
Faculty of Engineering

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

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(Accredited with A+ Grade by NAAC in the Second Cycle)

COIMBATORE 641 021, TAMIL NADU - INDIA.

DEPARTMENT OF CIVIL ENGINEERING
FACULTY OF ENGINEERING
RESEARCH PROGRAM – Ph.D in Civil Engineering
2020-2021 Batch and onwards

Subject Code	**Paper I**	**Instruction Hours / week**	**Credits**	**Maximum Marks (100)**
22RCE101	Paper- I: Research Methodology and Pedagogy	4	4	100
22RCE201	Paper- II: Research Publication Ethics	4	4	100
22RCE301	Paper- III: Advanced Environmental Engineering	4	4	100
22RCE302	Paper- III: Slope Stability And Land Slides			
22RCE303	Paper- III: Structural Dynamics and Earthquake Engineering			
22RCE304	Paper- III: Theoretical Soil Mechanics			
22RCE305	Paper- III: Soil Dynamics And Machine Foundations			
22RCE306	Paper- III: Soil Structure Interaction			
22RCE307	Paper- III: Rock Mechanics In Engineering Practice			
22RCE308	Paper- III: Reinforced Soil Structures			
22RCE309	Paper- III: Earthquake Analysis And Design of Structures			
22RCE310	Paper- III: Experimental Stress Analysis			
22RCE311	Paper- III: Repair andRehabilitation of Irrigation Structures			
22RCE312	Paper- III: Advanced Concrete Technology			
22RCE313	Paper- III: Prefabricated Structures			
22RCE314	Paper- III: High Performance Concrete			
22RCE315	Paper- III: Ground Improvement Techniques			
22RCE316	Paper- III: Geopolymer Cement and Concrete			
22RCE317	Paper- III: Pavement Engineering			
22RCE318	Paper- III: Sustainable Solid Waste collection and Management			
22RCE319	Paper- III: Remote Sensing / Spatial Information Technology			
22RCE320	Paper- III: Groundwater modeling and Management			
22RCE321	Paper- III: Advanced Treatment Techniques for industrial Wastewater			
22RCE322	Paper- III: Environmental Policies and Legislations			
22RCE323	Paper- III: Construction Project Management			
22RCE324	Paper- III: Traffic Engineering and Management			
	Program Total	**12**	**12**	**300**

22RCE101 **Research Methodology and Pedagogy** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To impart knowledge in the concept of problem identification and research methodology
2. To familiarize with basic of research and the research process
3. To demonstrate the different types of research and its applicability
4. To comprehend the knowledge of social research
5. To exhibit in sampling design and sampling techniques
6. To enrich the knowledge in writing a good research report.

COURSE OUTCOMES

1. Read, interpret, and critically evaluate social research.
2. Identify, explain, and apply the basic concepts of research, such as variables, operationalization, sampling, reliability, and validity.
3. Recognize the ethical issues involved in research, and practice ethical research standards.
4. Identify and explain the difference between quantitative, qualitative, and mixed methods research and what types of research questions can be answered with each method.
5. Use theory and previous research to create research questions and hypotheses and to identify and analyze the appropriate method and variables needed for research questions.
6. Use a variety of research methods through hands-on experience.

UNIT I - HIGHER EDUCATION AN INTRODUCTION

Historical perspectives, the objectives of higher education, role of higher education-social focus, curricular focus, administrative focus, drivers of change in higher education-globalization, changing demographics, structuring of employment, technological change, demand of accountability, consumerism,. Expectations by employers, rate of knowledge growth, campus demographics, concern for community. Restructuring and new patterns of decision making.

UNIT II - RESEARCH PROCESSES AND METHODOLOGY

Introduction to Research – Research strategies – Ethics – Code of conduct for Research – Health and Safety – IPR – Research Events – Networks – Outreach Activities – Best Research practices – Quality assurance for Research – Career Management for Researchers – Research seminars – Journal critiques -.

UNIT III - EFFECTIVE RESEARCH SKILLS

Data collection – Modeling – Simulation – Analysis – Prototyping – Presentation Skills – Data Presentation Skills – Research Writing skills (For Articles, Reports, Journals and Thesis) – Creative Skills – Effective Interview Skills – Team Building Skills – Communication and Interpersonal Skills – knowledge Transfer skills – Vivo voce – Teaching and Information Skills – Effective use of Library – Survey Skills – Planning and Control Methods – Statistical Tools – Patents and Copyrights – Advanced Research Techniques and Tools.

UNIT IV - TECHNIQUES OF TEACHING AND EVALUATION

Large group techniques – lecture, seminar, symposium, panel discussion-project approaches and workshop. Small Group techniques-group discussion simulation, role playing-Buzz techniques,

brain storming, case discussion and assignment…system approach in education. Individualized techniques-CAI Keller plan – PSI and programmed learning-methods of evaluation-self evaluation and student evaluation in higher education, question banking, diagnostic testing and remedial teaching.

UNIT V - ESSENTIALS FOR EFFECTIVE COMMUNICATION IN ENGLISH

Improving Vocabulary stock-general and technical vocabulary-British and American vocabulary-homophones & homonyms, idioms and phrases-Different grammatical functions of the same word-Grammar-Tenses, Voice, reported speech, Modals, spoken English structures, formal and informal-letters, project reports, descriptions, circulars, synopsis and summary writing. Listening skills for competitive exams-Reading skills-skimming and scanning – Reading journals, magazines and newspapers for comprehension.Practical use of English – conversation, seminars, individual speeches and group discussions. Reference skills-Using dictionary, thesaurus and encyclopedia effectively. Error shooting for better use of English.

Suggested Readings

1. Alley, Michael, 'The Craft of Scientific Writing', 3rd Edition, Springer (1996).
2. Alley, Michael, 'The Craft of Scientific Presentations", Springer(2003).

Reference Books

1. Hubbuch, Susan M., Writing Research Papers Across the Curriculum, 5th Edition, Thompson(2005).
2. Vedanayagam.E.G, Teaching technology for college teachers New Delhi - Sterling publishers (Pvt) Ltd, (1989).
3. Kumar.K.H., Educational technology, New Delhi- New age international (Pvt) Ltd(1997).
4. Tony Bates.A.N,Technology e-learning and distance education, New York, Rout ledge (2005).
5. Aggarwal. J.C., Essential of educational technology; Teaching Learning innovations in education-New Delhi- Vikas publishing house (p) Ltd. (1995)
6. Crow & Crow, Educational Psychology", Erusia Publishing House New Delhi, (1998).
7. M. Ashraf Rizvi., Effective technical communication, TataMcGraw Hill Co.Ltd, (2005).

Websites:

www.english4engineer.com
www.learn4good.com/language/engineer

22RCE201 **Research Publication Ethics** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

Course Objectives

- To understand the philosophy of science and ethics, research integrity and publication ethics. To identify research misconduct and predatory publications.
- To understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.). To understand the usage of plagiarism tools.
- To familiarize participants with basic of research and the research process.
- To enable the participants in conducting research work and formulating research synopsis and report.
- To familiarize participants with Statistical packages such as SPSS/EXCEL.
- To impart knowledge for enabling students to develop data analytics skills and meaningful interpretation to the data sets so as to solve the business/Research problem.

Course Outcomes

- Able to describe and apply theories and methods in ethics and research ethics
- To acquire an overview of important issues in research ethics, like responsibility for research, ethical vetting, and scientific misconduct.
- Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
- Have basic knowledge on qualitative research techniques
- Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis
- Have basic awareness of data analysis-and hypothesis testing procedures

UNIT I –PHILISOPHY AND ETHICS

Introduction to Philisophy: Definition, Nature and scope, concept, branches – Ethics: Definition, moral philosophy, nature of moral judgements and reactions.

UNIT II–SCIENTIFIC CONDUCT

Ethics with respect to science and research – Intellectual honesty and research integrity – Scientific misconduct: Falsification – Fabrication and Plagiarism (FFP) – Redundant publications : duplicate and overlapping publications – salami slicing – Selecting reporting and misrepresentation of date.

UNIT III - Publication Ethics

Publication Ethics: Definition, Introduction and importance – Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. – Conflicts of interest – Publication Misconduct:definition, concept, problems that lead to unethical behavior and vice versa, type – Violation of publication ethics, authorship and contributorship – identification of publication misconduct, complaints and appeals – Predatory publishers and journals.

UNIT IV–PUBLICATION MISCONDUCT

Group Discussions : Subject specific ethical issues, FFP, authorship – Conflicts of interest – Complaints and appeals: examples and fraud from india and abroad.

Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools.

UNIT V–DATABASES AND RESEARCH METRICS

Database: Indexing database – Citation database: Web of Science, Scopus, etc

Research metrics: Impact Factor of Journal as per journal Citation report, SNIP, SJR, IPP, Cite Score – metrics: h- index, g index, i10 index, altmetrics.

UNIT VI – DEVELOPMENT OF E- CONTENT & IPR

Integrated Library management System (ILMS): e- journals – e-books – e- shodhsindu – shodhganga – Database – e- content Development – Learning management System (LMS) – e-PG – Pathshala – CEC (UG) SWAYAM – MOOCs -NPTEL -NMEICT.

IPR: patent – Copyrights – Trademark – Geographical Indication.

PRACTICE:

Open Access Publishing

Open access publications and initiatives – SHERPA / RoMEO online resource to check polisher copyright & Self – archiving policies – Software tool to identify predatory publications developed by SPPU – Journal finder / Journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester,etc.

22RCE301 Advance EnvironmentalEngineering 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 Marks External: 100 Total: 100
End Semester Exam: 3 Hours

Course Objectives:

1. To provide the engineering graduates with technical expertise in Environmental Engineering which will enable them to have a career and professional accomplishment in the public or private sector.
2. To address the complexities of real-life environmental engineering problems related to water supply, sewerage, sewage treatment, waste management industrial pollution prevention and control.
3. To Identify and develop processes and technologies to meet desired environmental protection needs of society
4. To formulate solutions that are technically sound, economically feasible, and socially acceptable.
5. To design systems, processes, and equipment for control and remediation of water, air, and soil quality environment within realistic constraints of economic affordability and social acceptability
6. Have a knowledge of contemporary environmental issues and an ability to engage in life-long learning

Course Outcomes:

1. The students are expected to be able to identify, formulate, and solve environmental engineering problems using the techniques, skills, and modern engineering tools necessary for environmental engineering practice.
2. Assess the potential environmental impacts of development projects and design mitigation measures**.**
3. Have basic knowledge about environment protection and operation of pollution control devices.
4. Design and conduct experiments, as well as interpret data and communicate effectively.
5. Function in multi-disciplinary teams and understand the ethical and professional responsibility.
6. Find professional level employment as Environmental Engineers or pursue higher studies

UNIT I - SOLID WASTE TREATMENT AND DISPOSAL

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes - Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – closure of landfills – landfill remediation.

UNIT II - INDUSTRIAL WASTEWATER TREATMENT

Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors -

Chemical oxidation – Ozonation – carbon adsorption – Photo-catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.- Treatability studies.

UNIT III - AIR QUALITY MONITORING AND CONTROL TECHNIQUES:

Air pollutants: Sources, classification, Combustion Processes, pollutant emission, Effectson Health, vegetation, materials, atmosphere, Reactions of pollutants Scales of APstudies, effects as per scales, Air sampling, pollution measurement methods, Ambient airquality and emission standards, Air pollution indices, Air Act, legislation and regulations,Removal of gaseous pollutants. Particulate emission control; bioscrubers, biofilters,Indoor air quality.

UNIT IV- SURFACE WATER HYDROLOGY
HYDROLOGIC PROCESSES

Rainfall – Rain gauges – Adequacy of network – Spatial and temporal distribution – frequency and intensity / duration analysis – Consistency – missing data – Abstractions – Infiltration – Evaporation – Interception – Process, estimation and measurement – Depression and detention storages.

RUNOFF ESTIMATION

Components – Factors affecting runoff – Catchment characteristics – Flow measurements – Stream gauging – Floats, current meters – Venturi, Cut-throat and Parshall flumes – Rating curves – Aquastic Doppler velocity meter – Estimation – SCS and strange table methods – Empirical equations – Rainfall – Runoff models – TANK model – Tank clustered catchments.

UNIT V - REMOTE SENSING

Remote Sensing, GIS and GPS Techniques and their applications in Environmental Studies.Softwares in Environmental Engineering.Pollutant Transport Mechanisms and Modelling, Hazardous Waste Management, Waste Minimization Techniques, Environmental Risk Management

Suggested Readings

1. Manual on water supply and Treatment ",CPHEEO, Ministry of Urban Development, GOI, New Delhi (1999).
2. Manual on Sewerage and Sewage Development ",CPHEEO, Ministry of UrbanDevelopment, GOI, New Delhi (1993).
3. B.A. Hauser, " Practical Hydraulics Hand Book ", Lewis Publishers, New York, (1991).
4. M.J. Hammer, " Water and Wastewater Technology ", Regents/Prentice Hall, New Jersey.
5. Franzini, J., Freyberg, D., Linsley, R., and G. Tchobanoglous, “WaterResources Engineering”. McGraw Hill (1991).
6. Reed, S.C. and Crites, R.W.,“Natural Systems for Waste Management and Treatment” .McGraw Hill, (1996).
7. Guyer, H.H., “Industrial Processes and Waste Stream Management”.WileyInterscience (1998).
8. Bishop, P.,“Pollution Prevention: Fundamentals and Practice”. McGraw Hill, (2000).
9. American Water Works Association, “Water Treatment Plant Design”, (3rd Ed.).McGraw-Hill, (1997).
10. Kawamura, S., “Integrated Design and Operation of Water Treatment Facilities”**.**Wiley and Sons (2000).

22RCE302 **Slope Stability and Land Slides** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

Course Objectives:

1. Understand the engineering properties soil and rock to estimate their strength characteristics for slope stability analysis
2. Describe the different methods of slope stability analysis
3. Evaluate the infinite slopes based on the stability analysis
4. Describe the nature of landslides on various soils for stability analysis
5. Evaluate the behavior of slopes using instrumentation techniques
6. Applications of field observation techniques for understanding the landslides formation on soils

Course Outcomes:

1. Understand the various slope failures and causes of Failures
2. Describe the different methods of slope stability analysis
3. Analysis of non-uniform slopes with various methods
4. Analysis and design of the landslide detection and the stability of slopes on various soils
5. Understand the basic concepts and analysis of field observations and slope stabilization
6. Applications of various techniques in landslide detection and monitoring techniques and understand the role of landslides in the earth system

UNIT I - Stability of Slopes

Introduction – Importance – General characteristics - Types of failures – Causes of failures – Purpose of stability computation – Investigation of failures – Procedure – Case studies.

UNIT II - Stability Analysis

Stability analysis – Method of slices – Friction circle method – Soils with cohesion – Soils with cohesion and angle of internal friction. Critical states for design for embankments – Stability computations – Evaluation of pore water pressure.

UNIT III - Irregular Slopes

Non-uniform soils – Janbu's analysis – Taylor's analysis – Bishop's analysis – Total stress and effective stress approaches – composite surfaces of sliding – Block sliding.

UNIT IV - Land Slides

General Characteristics -sources – Stability of Hill side slopes – Open cuts – Engineering problems involving the stability of slopes – Cuts in sand – Cuts in loess – Homogeneous and soft clay slopes – Sudden spreading of clay slopes – Clay flows - Clays containing pockets and sand masses – Slides in stiff clay slopes on shale – Slopes on weathered rock; talus slopes, slopes on over consolidated clays – Slides along coastal areas and tropically weathered residual soils – long term stability of clay slopes.

UNIT V - Field Observations and Slope Stabilization

Field instrumentation – Observation studies during construction – Post construction, piezometers – Settlement plates – Inclinometer – Case histories.

Compaction of new embankments – Compaction of natural masses of soil and existing fills – Compaction of deep deposits of sand – Vibroflotation – Compaction of compressible soils – Drainage as a means of stabilization – Use of Geotextiles – Soil nailing.

Suggested Readings

1. Chowdhury, D.F., "Slope analysis", Prentice Hall, (1988).
2. Winterkorn, H.F. and Fang, H.Y., "Foundation Engineering" Handbook, Von Nostrand Reinhol, (1994).
3. Bramhead, E.N., "The Stability of Slopes", Blacky Academic and Professionals Publications, Glasgow, (1986).
4. Anderson, M.G., and Richards, K.S.,"Slope Stability", John Wiley,(1987).

22RCE303 Structural Dynamics and Earthquake Engineering 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 Marks External: 100 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVE:

1. To introduce the basics of Earthquake Engineering
2. To introduce the engineering seismology, building geometrics & characteristics, structural irregularities,
3. To introduce tips on earthquake engineering - do's and don'ts
4. To introduce cyclic loading behaviour of RC, steel and pre-stressed concrete elements
5. To discuss code provisions and their application on different types of structures
6. To apply codal provisions on different types of structures

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Apply the basics of Earthquake Engineering
2. Demonstrate the dynamics of structural system under earthquake load
3. Analyze the influence of the structural / geometrical design in building characteristics
4. Demonstrate the cyclic loading behaviour of RC steel and pre-stressed concrete elements
5. Apply codal provisions on different types of structures.
6. Cyclic loading behaviour of RC, steel and pre-stressed concrete elements

UNIT I Theory of Vibrations

Difference between static loading and dynamic loading – Degree of freedom – idealisation of structure as single degree of freedom system – Formulation of Equations of motion of SDOF system – D"Alemberts principles – effect of damping – free and forced vibration of damped and undamped structures – Response to harmonic and periodic forces.

UNIT II Multiple Degree of Freedom System

Two degree of freedom system – modes of vibrations – formulation of equations of motion of multi degree of freedom (MDOF) system – Eigen values and Eigen vectors – Response to free and forced vibrations – damped and undamped MDOF system – Modal superposition methods.

UNIT III Elements of Seismology

Elements of Engineering Seismology – Causes of Earthquake – Plate Tectonic theory – Elastic rebound Theory – Characteristic of earthquake – Estimation of earthquake parameters – Magnitude and intensity of earthquakes – Spectral Acceleration.

UNIT IV Response of Structures to Earthquake

Effect of earthquake on different type of structures – Behaviour of Reinforced Cement Concrete, Steel and Prestressed Concrete Structure under earthquake loading – Pinching effect – Bouchinger Effects – Evaluation of earthquake forces as per IS:1893 – 2002 – Response Spectra – Lessons learnt from past earthquakes.

UNIT V Design Methodology

Causes of damage – Planning considerations / Architectural concepts as per IS:4326 – 1993 – Guidelines for Earthquake resistant design – Earthquake resistant design for masonry and Reinforced Cement Concrete buildings – Later load analysis – Design and detailing as per IS:13920 – 1993.

Suggested Readings

1. Chopra, A.K., "Dynamics of Structures – Theory and Applications to Earthquake Engineering", 4th Edition, Pearson Education, (2002).
2. Agarwal. P and Shrikhande. M., "Earthquake Resistant Design of Structures", Prentice Hall of India Pvt. Ltd, (2007).
3. Biggs, J.M., "Introduction to Structural Dynamics", McGraw Hill Book Co., New York, (1964).
4. Dowrick, D.J., "Earthquake Resistant Design", John Wiley & Sons, London, (2009).
5. Paz, M. and Leigh., "Structural Dynamics – Theory & Computation", 4th Edition, CBS Publishers & Distributors, Shahdara, Delhi, (2006).

22RCE304 **Theoretical Soil Mechanics** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

Course Objectives:

1. Describe the engineering behaviour of soil and rock for understanding the slope stability analysis
2. Acquire the basic knowledge on different methods of slope stability analysis
3. Describe the equilibrium analysis to understand the stress-stain behaviour in infinite slopes
4. Describe the various theories and mechanism for estimating the engineering behavior of soils
5. Evaluate the behavior of porous media in different soil conditions for slope stability analysis
6. Applications of basic concepts and field testing techniques to estimate the problems associated with geotechnical engineering structures

Course Outcomes:

1. Understand the theory of elasticity and equation of equilibrium and compatibility in soil mechanics
2. Describe the stresses and displacement in soil with fundamental solutions
3. Understand the stress – strain relationship using limit equilibrium analysis
4. Ability to apply theory of elasticity / plasticity / rheological modeling to analyse and obtain solution to challenges involving engineering behavior of soils
5. Analysis of flow through porous media in different soil conditions
6. Application of various principles and theories to analyze the problems related to soil mechanics

UNIT I - Theory of Elasticity

Introduction – Material behaviour – Idealistic behaviour – Elastic, viscous and plastic – Elasticity and stability problems, concept of stress and strain – Plane stress, plane strain and axisymmetric problems – Equation of equilibrium and compatibility – Stress functions.

UNIT II - Stresses and Displacements (Elastic Solutions)

Stresses in elastic half-space medium by external loads – Fundamental solutions – Boussinesq, Flamant, Kelvin and Mindlin solution – Applications of fundamental solutions – Anisotropic and non-homogeneous linear continuum – Influence charts – Elastic displacement.

UNIT III - Limit Equilibrium Analysis

Limit equilibrium analysis – Perfectly plastic material – Stress – strain relationship – Stress and displacement field calculations – Slip line solutions for undrained and drained loading.

UNIT IV - Limit Analysis

Limit analysis – Principles of virtual work – Theorems of plastic collapse – Mechanism for plane plastic collapse – Simple solutions for drained and undrained loading – Stability of slopes, cuts and retaining structures. Centrifuge model – Principles and scale effects, practical considerations.

UNIT V - Flow Through Porous Media

Flow through porous media – Darcy's law – General equation of flow – Steady state condition – Solution by flow net – Fully saturated conditions – Flownet in anisotropic soils – construction of flownet for different cases.

Suggested Readings

1. Aysen, A., "Soil Mechanics: Basic concepts and Engineering Application", A.A.Balkema Publishers, (2002).
2. Ulrich Smoltc, YK, "Geotechnical Engineering Handbook (Vol. 1)", Ernot&Sohn, (2002).
3. Aysen, A., "Problem Solving in Soil Mechanics", A.A.Balkema Publisher, (2003).
4. Davis, R.O., and Selvadurai, A.P.S., Elasticity and Geomechanics, Cambridge University Press, (1996).
5. Taylor, R.N.,"Geotechnical Centrifuge Technology", Blackie Academic and Professional, (1995).
6. Wai-Fah Chen, and Liu, X.L.," Limit Analysis in Soil Mechanics, Elsevier Science Ltd., (1991).
7. Muni Budhu, "Soil Mechanics and Foundations", John Wiley and Sons, Inc, Network, (2000).
8. Atkinson, J.H., "Foundations and Slopes", McGraw Hill, (1981).
9. Harr, M.E., "Foundations of Theoretical Soil Mechanics, McGraw Hill, (1966).
10. Cedergren, H.R.," Seepage Drainage and Flow nets", John Wiley(1997).

22RCE305 **Soil Dynamics and Machine Foundations** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

Course Objectives:

1. Acquire the basic knowledge on vibration theories for dynamic analysis of floundations
2. Understand the basic concepts on dynamic properties of soil using various field and laboratory testings
3. Describe the types of machine foundations to undersand the applicability of various vibration theories
4. "Describe the modes of vibration in foundation systems and to understand the importance of designing
5. machine foundation for reciprocating and impact machines."
6. Evaluate the vibration isolation techniques using springs and damping materials
7. Acquire the ability to design machine foundations with different vibration theories

Course Outcomes:

1. Understand the fundamental concepts of theory of vibration and the various terminology. encompassed to study the behavior of soils due to the effects of dynamic loads.
2. Describe the dynamic soil properties & their determination by field and laboratory tests.
3. Understand the general principles of analysis and design of machine foundation.
4. Analyze and design the foundations for machineries of reciprocating, impact and rotary type.
5. Analyze the active and passive isolation problems for machine foundation.
6. Application of various principles and analyze various problems related to machine foundation.

UNIT I - Theory of Vibration

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

Dynamic stress – Strain characteristics – Principles of measuring dynamic properties – Laboratory techniques – 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

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

UNIT IV - Design of Machine Foundation

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 of vibration of a rigid foundation – Foundations for reciprocating machines,

impact machines, Two – Cylinder vertical compressor, Double-acting steam hammer – Codal recommendations.

Emprical approach - Barken's method – Bulb of pressure concept – Pauw's analogy – Vibration table studies.

UNIT V - Vibration Isolation

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.

Suggested Readings

1. KameswaraRao, N.S.V., "Dynamics soil tests and applications", Wheeler Publishing, New Delhi, (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. KameswaraRao,"Vibration Analysis and Foundation Dynamics", Wheeler Publishing, New Delhi, (1998).
6. Swami Saran,"Soil Dynamics and Machine Foundation", Galgotia publications Pvt. Ltd. New Delhi, (2010).
7. Das B.M., "Principles of Soil Dynamics", McGraw Hill, (1992).
8. KrammerS.L.,"Geotechnical Earthquake Engineering", Prentice Hall, International series, Pearson Education (Singapore) Pvt Ltd, (2004).

22RCE306 **Soil Structure Interaction** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

Course Objectives:

1. Explain the effects of soil flexibility in the response of the structure
2. Analyse the structure with soil structure interaction effects to obtain the realistic response
3. Describe the numerical analysis of plates on elastic medium
4. Analyse the structure with soil structure interaction effects to obtain the realistic response in pile and pile-raft system
5. Analyse the structure with soil structure interaction effects to obtain the realistic response in laterally pile and pile-raft system
6. "Acquire the ability to design the geotechnical engineering structures using the concept of soil structure interaction"

Course Outcomes:

1. Understand the various soil response models applicable to soil-foundation interaction analysis.
2. Analyze the beams on elastic foundation and its applications
3. Analyze the plates on elastic medium and its applications
4. Assess the elastic solutions for problems of pile and pile-raft system.
5. Assess the elastic solutions for problems of laterally pile and pile-raft system
6. Application of various principles and evaluate the soil stiffness and damping ratio

UNIT I - Soil - Foundation Interaction

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

UNIT II - Beams on Elastic Foundation - Soil Models

Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness – Analysis through application packages.

UNIT III - Plate on Elastic Medium

Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates, simple solutions, Analysis of braced cuts – Application packages.

UNIT IV - Elastic Analysis of Pile

Elastic analysis of single pile, Theoretical solutions for settlement and load distribution, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap – Pile raft – Application packages.

UNIT V - Laterally Loaded Pile

Load deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Interaction analysis, pile raft system, solutions through influence charts - Application packages.

Suggested Readings

1. Saran, S., “Analysis and design of substructures:, Taylor & Francis Publishers, (2006).
2. Hemsley, J.A., “Elastic Analysis of Raft Foundations”, Thomas Telford, (1998).
3. Poulos, H.G., and Davis, E.H., “Pile Foundation Analysis and Design”, John Wiley, (2008).
4. Murthy, V.N.S., “Advanced Foundation Engineering”, CBS Publishers, New Delhi, (2007).
5. McCarthy, D.F.,“Essentials of Soil Mechanics and Foundations: Basic Geotechnics”, Sixth Edition, Prentice Hall, (2002).
6. Scott, R.F., “Foundation Analysis”, Prentice Hall, (1981).
7. ACI 336, “Suggested Analysis and Design Procedures for Combined Footings and Mats”, American Concrete Institute, Delhi, (1988).

22RCE307 **Rock Mechanics In Engineering Practice** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

Course Objectives:

1. Describe the various properties and behaviour of various geological formation
2. Describe the various theories and concepts on strength criteria of rocks
3. Acquire the basic knowledge on the design of geotechnical engineering structures using case studies
4. Describe the slope stability analysis for critical slopes and apply the concept of factor of safety
5. Acquire the knowledge on the effect of reinforcements in the remedial measures of slope stability
6. Application of basic concepts of rock mechanics for designing the geotechnical engineering structures

Course Outcomes:

1. Understand the various distribution, geological characters and civil engineering significance of major rock formations of India
2. "Describe the strength criteria of rocks and behaviour of rock under hydrostatic and deviatoric loadings "
3. Analyze the design aspects and stress measurements in rocks
4. Assess the stability analysis of rock slopes and various remedial measures for critical slopes
5. Assess the reinforcement techniques in stability of rocks
6. Apply the geological knowledge in civil engineering planning and development based on the properties of rocks

UNIT I - Classification of Rocks

Rocks of peninsular India and the Himalayas – Index properties and classification of rock masses, competent and incompetent rock – Value of RMR and ratings in field estimations.

UNIT II - Strength Criteria of Rocks

Behaviour of rock under hydrostatic compression and deviatoric loading – Modes of rock failure – Planes of weakness and joint characteristics – Joint testing, Mohr – Coulomb failure criterion and tension cut-off, Hoek and Brown Strength criteria for rocks with discontinuity sets.

UNIT III - Design Aspects in Rocks

Insitu stresses and their measurements, flat jack - Over and under coring methods – stress around underground excavations – Design aspects of openings in rocks – Case studies.

UNIT IV - Slope Stability of Rocks

Rock slopes – Role of discontinuities in slope failure, slope analysis and factor of safety – Remedial measures for critical slopes – Case studies.

UNIT V - Reinforcement of Rocks

Reinforcement of fractured and jointed rocks – Shotcreting – Bolting – Anchoring – Installation methods – Case studies.

Suggested Readings

1. Goodman, R.E.,“ Introduction to Rock Mechanics”, John Wiley and Sons,(1989).
2. Hool, E and Bray, J., “Rock Slope Engineering, Institute of Mining and Metallurgy”, U.K. (1981).
3. Hoek, E and Brown, E.T., “Underground Excavations in Rock, Institute of Mining and Metallurgy”, U.K. (1981).
4. Bazant, Z.P.,“ Mechanics of Geomaterials Rocks, Concrete and Soil”, John Wiley and Sons, Chichester, (1985).
5. Wittke, W., “Rock Mechanics: Theory and Applications with Case Histories”, Springerverlag, Berlin, (1990).

22RCE308 **Reinforced Soil Structures** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

Course Objectives:

1. Describe the behaviour and performance of soil - reinforcement interactions using various concepts and mechanisms of reinforced soil
2. Acquire the basic knowledge on the materials properties of different soil reinforcements
3. Describe the design concepts and applications of soil reinforcements
4. Describe the need for geosynthetics in the design of drainage and landfill program
5. Acquire the basic concepts from the case studies on the soil nailing techniques
6. Acquire the ability to analyze and design the geotechncial engineering structures using soil reinforcement techniques

Course Outcomes:

1. Understand the various principles and mechanisms of reinforced soil techniques in different soils
2. Describe the materials used in reinforced soil structures and its laboratory testing
3. Assess the design principles of reinforced soil of various structures
4. Assess the use of geosynthetics in drainage requirements and landfill designs program
5. Describe the soil nailing concepts and various case histories
6. Apply the principles of soil reinforcement in engineering constructions

UNIT I - Principles and Mechanisms

Historical background – Initial and recent developments – Principles – Concepts and mechanisms of reinforced soil – Factors affecting behaviour and performance of soil – Reinforcement interactions.

UNIT II - Materials and Material Properties

Materials used in reinforced soil structures- Fill materials, reinforcing materials, metal strips, Geotextile, Geogrids, Geomembranes, Geocomposites, Geojutes, Geofoam, natural fibres, coir Geotextiles – Bamboo – Timber – Facing elements – Properties – Methods of testing – Advantages and disadvantages – Preservation methods.

UNIT III - Design Principles and Applications

Design aspects of reinforced soil – Soil reinforcement function – Separator, Filtration, Drainage, Barrier function – Design and applications of reinforced soil of various structures – Retaining walls – Foundations - Embankments and slopes.

UNIT IV - Geosynthetics and Applications

Introduction – Historical background – Applications - Design criteria – Geosynthetics in roads – Design – Giroud and Noiray approach – Geosynthetics in landfills – Geosynthetic clay liner – Design of landfills – Construction of landfills using geosynthetics-Barrier walls- Reinforced Soil retaining walls- Reinforced soil slopes.

UNIT V - Soil Nailing and Case Histories

Soil nailing – Introduction – Overview – Soil – Nail interaction – Behaviour – Design procedure – Behaviour in seismic conditions.

Performance studies of reinforced dams, embankments, Pavements, Railroads, Foundations - Case studies.

Suggested Readings

1. Jewell, R.A.," Soil Reinforcement with Geotextile", CIRIA, London, (1996).
2. John, N.W.M.," Geotextiles", John Blackie and Sons Ltd., London, (1987).
3. Jones, C.J.F.P., "Earth Reinforcement and Soil Structures", Earthworks, London, (1982).
4. Koerner, R.M., "Designing with Geosynthetics", (Third Edition), Prentice Hall, (1997).
5. Proc. Conference on polymer and Reinforcement, Thomas Telford Co., London, 1984.
6. Gray, D.H., and Sotir, R.B.,"Biotechnical and Soil Engineering Slope Stabilization", A Practical Guide for Erosion Control, John Wiley & Son Inc., New York, (1996).
7. RamanathaAyyar, T.S., Ramachandran Nair, C.G. and Balakrishna Nair, N., "Comprehensive reference book on Coir Geotextile", Centre for Development for Coir Technology, (2002).

22RCE309 Earthquake Analysis and Design Of Structures 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 Marks External: 100 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To develop the equation of motion for vibratory systems and solving for the free and forced response.
2. To Create simple models for engineering structures.
3. To understand the dynamic analysis result for design analysis and research purposes.
4. To understand Structural dynamics theory to Earthquake analysis response and design of structure.
5. To gain the Knowledge of mathematics science and engineering to create mathematical modeling
6. To Analyse the different system with distributed load

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Apply Knowledge of mathematics, science and engineering by developing the equation of motion for vibratory systems and solving for the free and forced response.
2. Create simple models for engineering structures using knowledge of structural dynamic
3. Intercept dynamic analysis result for design analysis and research purposes.
4. Apply Structural dynamics theory to Earthquake analysis response and design of structure.
5. Apply Knowledge of mathematics science and engineering to create mathematical modeling
6. Analyze the different system with distributed load

UNIT I - EARTHQUAKES AND GROUND MOTION

Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation.

UNIT II - EFFECTS OF EARTHQUAKE ON STRUCTURES

Dynamics of Structures (SDOFS/ MDOFS), Response Spectra - Evaluation of Earthquake Forces as per codal provisions - Effect of Earthquake on Different Types of Structures - Lessons Learnt from Past Earthquakes

UNIT III - EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES

Structural Systems - Types of Buildings - Causes of damage - Planning Considerations - Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Masonry Buildings - Design consideration – Guidelines.

UNIT IV - EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis – Capacity based Design and detailing – Rigid Frames – Shear walls.

UNIT V - VIBRATION CONTROL TECHNIQUES

Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- Case Studies, Important structures.

Suggested Readings

1. Bruce A Bolt, "Earthquakes" W H Freeman and Company, New York, (2004).
2. C. A. Brebbia,"Earthquake Resistant Engineering Structures VIII",WIT Press, (2011).
3. Mohiuddin Ali Khan, "Earthquake-Resistant Structures: Design, Build and Retrofit", ElsevierScience& Technology, (2012).
4. Pankaj Agarwal and Manish Shrikhande,"Earthquake Resistant Design of Structures", Prentice Hall of India, (2009).
5. Paulay,T and Priestley, M.J.N.,"Seismic Design of Reinforced Concrete and Masonrybuildings", John Wiley and Sons, (1992).
6. S K Duggal,"Earthquake Resistant Design of Structures", Oxford University Press, (2007).

22RCE310 **Experimental Stress Analysis** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To measure the strain under static and dynamic loads.
2. To describe the mechanical, optical, pneumatic and electrical strain gauges
3. To create awareness about the fixing of gauges and temperature effects.
4. To analysis of measuring circuits and strains of different strain gauge rosettes.
5. To describe the measurements by using transducers and exciters.
6. To study about the fundamentals of Non-Destructive Testing.

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Explain the measurement of strain under static and dynamic loads.
2. Describe the Mechanical, optical, pneumatic and electrical strain gauges for strain measurement.
3. Create awareness about the fixing of gauges and temperature effects in bonded gauges and measure of stress in stress gauges.
4. Analysis of measuring circuits and strains of different strain gauge rosettes.
5. Describe the measurements by using transducers and exciters
6. Understand about the fundamentals of Non-Destructive Testing.

UNIT I - MEASUREMENTS & EXTENSOMETER

Principles of measurements, Accuracy, Sensitivity and range of measurements. Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.

UNIT II- ELECTRICAL RESISTANCE STRAIN GAUGES

Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheastone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

UNIT III- PHOTOELASTICITY

Two dimensional photo elasticity, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photo elasticity.

UNIT IV - BRITTLE COATING AND MOIRE METHODS

Introduction to Moire techniques, brittle coating methods and holography.

UNIT V - NON – DESTRUCTIVE TESTING

Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique.

Suggested Readings

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., andRamachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, (1984).

References

1. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc., NewYork, 2005, IV edition, (2005).
2. Hetyenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, (1972).
3. Pollock A.A.,"Acoustic Emission in Acoustics and Vibration Progress", Ed. Stephens R.W.B., Chapman and Hall, (1993).

22RCE311 **Repair and Rehabilitation of Irrigation Structures** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES

1. To enable the students for a successful career as water management professionals.
2. To create a potential among students in the area of irrigation management with specific enrichment to synthesis of data and their analysis.
3. To expose the students the need for an interdisciplinary approach in irrigation water management and providing a platform to work in an interdisciplinary team.
4. To provide students an ability to understand the applications of mathematical and scientific concepts to analyse intricate technical, social and environmental problems in irrigation water management and finding solutions for them.
5. To promote student awareness for a life-long learning process and inculcate professional ethics and codes of professional practice in water management.
6. To know about the Modernisation of Irrigation Systems

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Understand the concepts of soil-water-plant relationship as well as to expose them to the principles and practices of crop production.
2. Exposure to ground water, hydraulics of ground water related to drainage, drainage concepts, planning, design and management of drainage related irrigation system management
3. Understand the various principles of irrigation management and to analyse the different types of irrigation systems and their performances based on service-oriented approach.
4. To gain insight on local and global perceptions and approaches to participatory water resource management and to learn from successes and failures in the context of both rural and urban communities of water management.
5. Exposure on the use of economic concepts in irrigation development and to impart knowledge on economic planning so as to enable viable allocation of resources in the irrigation sector.
6. Understand about the Modernisation of Irrigation Systems

UNIT I - IRRIGATION SYSTEMS

Historical evolution of irrigation systems in India; its importance to agricultural production. Irrigation system classification – Nature of system modernization and rehabilitation. Distinction between rehabilitation and modernization; Rehabilitation and modernization objectives – Theory and Practice.

UNIT II - SYSTEM MAINTENANCE

Maintenance: essential, catch up, preventive and normal – Diagnostic analysis of flow, seepage and other parameters through Participatory Rural Appraisal, Rapid Rural Appraisal and Walkthrough Survey – Development and maintenance programme – Kudimaramath – Turnover – WUA.

UNIT III - DIAGNOSTIC ANALYSIS OF IRRIGATION SYSTEMS

System performance: history of inflow, cropping pattern, system alterations, distribution performance – Operational constraints – Management constraints – Resources constraints.

UNIT IV- REHABILITATION

Baseline survey – Deferred maintenance – Causes – Criteria used for taking rehabilitation programmes –Service Delivery Concepts- Software and hardware improvements – Prioritization – Role of water users' association – Monitoring and evaluation.

UNIT V - CASE STUDIES

Rehabilitation and modernization programmes – Periyar Vaigai Project – Walawe Project – Tank Modernization Project – Water Resources Consolidation Project. IAM WARM Project - DRIP - Case study of Rehabilitation using Water Delivery Concept.

Suggested Readings

1. CWR,Baseline Survey of Irrigation Commands, Centre for Water Resources, Anna University, Chennai, (2000).
2. IIMI and WALMI, "The Case of Mahi Kadana", WALMI, Gujarat, India, (1994),.
3. CSU, "Diagnostic Analysis of Irrigation Systems Volume 2: Evaluation Techniques. Water Management Synthesis Project", Colorado State University, USA, (1984).
4. WAPCOS, Technical Report No. 19-A, "Handbook for Improving Irrigation System Maintenance Projects", WAPCOS, New Delhi, (1989).
5. CWR, "Tank Modernization Project EEC Assistance: Monitoring and Evaluation. Final Reports", Centre for Water Resources, Anna University, Chennai, (2000).
6. CWR, "Planning and Mobilization of Farmers Organization and Turnover", Tamil Nadu Water Resources Consolidation Project. CWR and OM, Anna University, Chennai, (1997).

22RCE312 **Advanced Concrete Technology** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To know about the constituent materials of concrete and mix design principles.
2. To understand the concept of special concrete.
3. To study about the tests for durability of concrete
4. To study about recommendations of IS 456-2000 for quality control of concrete
5. To know about the concreting under special circumstances
6. To know about the tests for hardened concrete.

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Identify the constituent materials of concrete and mix design principles.
2. Describe the concept of special concrete.
3. Demonstrate the tests for durability of concrete
4. Categorize the quality control of concrete as per IS 456-2000 code
5. Develop the concreting under special circumstances
6. Will gain the knowledge of tests for hardened concrete.

UNIT I- INTRODUCTION

Concrete: Past, Present and Future- Constituent Materials --Strength of Concrete -Dimensional Stability of Concrete- Chemical and Mineral Admixtures-Properties of Fresh and hardened Concrete - Principles of Concrete Mix Design-Methods of Concrete mix design.

UNIT II - SPECIAL CONCRETES

Lightweight and Heavy Weight Concrete-High Strength Concrete-High Performance Concrete-Polymers in Concrete-Steel fiber Reinforced Concrete-Ferrocement Concrete-Vaccum Concrete-Shotcrete-Ready Mixed Concrete-SIFCON.

UNIT III - DURABILITY OF CONCRETE

Permeability-chemical attack-sulphate attack-Quality of water-marine conditions-
Thermal properties of concrete-fire resistance-methods of making durable concrete -
Mass Concrete-Formwork-Structural Concrete Block Masonry -Quality Control of Concrete Construction.

UNIT IV - FORMWORK AND QUALITY CONTROL

Formwork Materials and Systems-Specifications-Design-Recommendations of IS 456-2000 on Quality- Statistical Parameters and Variability-Errors in Concrete Constructions-Quality Management.

UNIT V - CONCRETING UNDER SPECIAL CIRCUMSTANCES

Underground Construction-Concreting in Marine Environment-Under eater Construction-Hot weather and Cold weather concreting.

Tests on Concrete : Evaluation of Strength of existing structures-investigation Techniques-Tests on Hardened Concrete-Non Destructive Testing-Semi destructive testing techniques-Tests on fresh Concrete-Load Test on Structural Components.

Suggested Readings

1.Neville, A.M., Properties of Concrete, Pitman Publishing Limited, London.

2. Shetty M.S.Concrete Technology,S.Chand and Company Ltd,.New Delhi, (2003).
3. Gambir,M.L., "Concrete Technology", Tata McGraw Hill, Publishing,Co,Ltd,NewDelhi, (2004).
4. Krishnaraju.N, "Design of Concrete mixes", Sehgal Educational Consultants Pvt.Ltd.,Faridabad.
5. IS:456-2000,Indian Standards Code of Practice for Pa\lain and Reinforced Concrete
6. IS: 10262, "Recommended Guidelines for Concrete Mix Design",1982.
7. Santhakumar,A.R., Concrete Technology, Oxford University Press, New Delhi.

22RCE313 **Prefabricated Structures** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To know about the modular coordination and production process of prefabricates
2. To understand the concept of Long wall and cross-wall large panel buildings.
3. To study about the design of large panels and stair cases
4. To study about the design of shear walls
5. To know about the design of industrial sheds and roof trusses.
6. To know about the hand book-based design of prefabricates.

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Identify the modular coordination and production process of prefabricates
2. Describe the long wall and cross-wall large panel buildings.
3. Design the large panels and stair cases
4. Design the shear walls
5. Design the industrial sheds and roof trusses.
6. Will gain the knowledge of hand book-based design of prefabricates.

UNIT I - DESIGN PRINCIPLES

General Civil Engineering requirements, specific requirements for planning and layout of prefabricates plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and codal provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls.

UNIT II - REINFORCED CONCRETE

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

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.

UNIT IV -WALLS

Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.

UNIT V - INDUSTRIAL BUILDINGS AND SHELL ROOFS

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

Suggested Readings

1. B.Lewicki, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam, London,New York, (2011).
2. Koncz.T., Manual of Precast Concrete Construction, Vol.I II and III, Bauverlag, GMBH, (1971).
3. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precast Concrete, Netherland BetorVerlag, (1978).
4. LassloMokk, Prefabricated Concrete for Industrial and Public Sectors, AkademiaiKiado, Budapest, (1964).
5. Murashev.V.,Sigalov.E., and Bailov.V., Design of Reinforced Concrete Structures, CBS publishers and distributors, New Delhi, (2003).
6. Gerostiza. C.Z., Hendrikson, C. and Rehat D.R., Knowledge Based Process Planning for Construction and Manufacturing, Academic Press, Inc, (1994).

22RCE314 **High Performance Concrete** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To know about the characteristics of concrete
2. To know about the design of concrete mixtures
3. To understand the concept micro & macroscopic behavior and theories of HPC
4. To study about the design of Fibre reinforced concrete as per ACI 318-99
5. To study about the design of shear walls
6. To know about the hand book-based design of prefabricates.

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Identify the modular coordination and production process of prefabricates
2. Show competency in design of advanced reinforced concrete structures.
3. Develop competence for applying of structures. Design the shear walls
4. Design the industrial sheds and roof trusses.
5. Will gain the knowledge of hand book-based design of prefabricates.
6. Understand the hand book-based design of prefabricates.

UNIT I – PERFORMANCE CHARACTERISTICS OF CONCRETE
General performance characteristics – cement effect on concrete strength – Portland cement and other hydraulic cement characteristics and content – performance comparison of various cements in concrete – water/cement ratio, aggregate and admixtures – permeability effects on performance of concrete – air voids and permeability – diffusion, sorptivity – freezing, thawing effect – concrete in cold weather –air entraining agents- ACI recommendations –hot weather concreting

UNIT II – ADMIXTURES AND DESIGN MIXTURES OF HPC
Mineral admixtures – chemical admixtures – strength requirements – selection of materials and proportions – flow chat for mixtures – mixture design – high performance light weight aggregates production, properties and proportioning – mixing and placement – creep, shrinkage and durability – thermal expansion ,conductivity and carbonation – offshore arctic environment – design of concrete mixtures – long term effects

UNIT III- CHARACTERISTICS, MICRO & MACRO MECHANICS
Concrete properties – mature elastic strength expressions – workability and cohesiveness, permeability, volumetric stability – ductility and energy absorption, constructability- bond to parent concrete – abrasion and fire resistance – micro & macroscopic behavior and theories – classical failure, crack propagation and failure mechanics theory – shear friction theory – confinement

UNIT IV – FRC & FRPC AND CODE OVER VIEW
FRC historical development, general characters and mixture proportioning – mechanical properties and mechanics of fiber reinforcement – plastic composites – GFRP & CFRP sheets –fire resistance – structural element designs as per ACI 318-99 – performance control for long term durability –

constituent materials , corrosion inhibiters – water, mixture proportioning – constructability, serviceability, quality control and quality assurance

UNIT V – ECONOMICS OF HPC & HPC in 21st CENTURY

Construction needs – design and rehabilitation considerations – monitoring and cost evaluation – expectations and conclusions - principal factors affecting cost –advantages using HPC- cost studies and comparisons

Suggested Readings

1. Edward G. Nawy, Fundamentals of high-performance concrete ,2nd edition John Wily & Sons, Australia.
2. Pierrie- Claude Aitcin E.& F.N Spon High performance concrete Technology and Engineering ,London.
3. Yves Malier –E & FN Spon High performance concrete from material to structure, London.
4. V.M.Malhotra, High performance concrete performance and quality of concrete structures,Proceedings of the 3rd international conference, (2002).

22RCE315 **Ground Improvement Techniques** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

COURSE OBJECTIVE:

1. At the end of the course student is expected to identify the problematic soil and suitable suggest remedial measures
2. To understand the different problematic soils and effect of ground improvement techniques.
3. To describe the seepage analysis and suitable dewatering systems for the particular soil conditions.
4. To express the concept of compaction efforts on ground improvement and their installation and working principles.
5. Describe the load transfer mechanism and effect of geo textiles reinforcements in ground improvement.
6. Describe the various stabilization methods for the different types of problematic soils.

COURSE OUTCOMES:

1. Student will be in a position to identify and evaluate the deficiencies if any in the deposits of a project area.
2. Capable of providing alternate methods to improve its character suitable to the project, so that the structures built will be stable and serve.
3. Describe the dewatering systems for different soil conditions and their effect.
4. Express the working principles of different compaction methods on improving weak deposits.
5. Express the design of geo textiles reinforcements for ground improvement.
6. Express the soil stabilization methods for the problematic soils.

UNIT I - DEWATERING

Introduction - Scope and necessity of ground improvement in Geotechnical engineering basic concepts and philosophy. Drainage - Ground Water lowering by well points, deep wells, vacuum and electro-osmotic methods. Stabilization by thermal and freezing techniques.

UNIT II - COMPACTION AND SAND DRAINS

Insitu compaction of granular and cohesive soils, Shallow and Deep compaction methods - sand piles – concept, design, factors influencing compaction. Blasting and dynamic consolidation – Preloading with sand drains, fabric drains, wick drains etc. – Theories of sand drain – design and relative merits of above methods.

UNIT III - STONE COLUMN, LIME PILES AND SOIL NAILING

Stone column, lime piles – Functions – Methods of installation – design, estimation of load carrying capacity and settlement. Root piles and soil nailing - methods of installation – Design and Applications – case studies.

UNIT IV - EARTH REINFORCEMENT

Earth reinforcement – Principles and basic mechanism of reinforced earth, simple design, Synthetic and natural fibre based Geotextiles and their applications. Filtration, drainage, separation, erosion control – case studies.

UNIT V - GROUTING

Grouting – Types of grout – Suspension and solution grouts – Basic requirements of grout. Grouting equipment – injection methods - jet grouting – grout monitoring – Electro – chemical stabilization – Stabilization with cement, lime etc. – Stabilization of expansive clays.

Suggested Readings

1. P. Purushothama Raj, Ground Improvement Technique, Laxmi Publications (P) Ltd (2005).
2. Nihar Ranjan Patra : Ground Improvement Techniques ; Vikas Publishing house (2005).
3. RamanathaAyyar, T.S., Ramachandran Nair, C.L. and Balakrishnan Nair, N., Comprehensive Reference book on Coir Geotextiles, Centre for development of Coir Technology, (2002).
4. Koerner, R.M., Designing with Geosynthetics, Third Edition, Prentice Hall, (1997).
5. Jewell, R.A., Soil Reinforcement with Geotextiles, CIRIA, London, (1996).
6. Jones, J.E.P., Earth Reinforcement and Soil Structure, Butterworths, (1985).
7. Rowe, R.K.,Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, (2001).
8. Moseley, M.D., Ground Treatment, Blackie Academic and Professional, (1998).
9. Das, B.M, Principles of Foundation Engineering, Fourth Edition, PWS Publishing, (1999).
10. Koerner, R.M. and Welsh, J.P, Construction and Geotechnical Engineering using Synthetic Fabrics, John Wiley, (1990).
11. Hehn, R.W, Practical Guide to Grouting of Underground Structures, ASCE, (1996).
12. Shroff, A.V, Grouting Technology in Tunneling and Dam, Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi, (1999).

22RCE316 **Geopolymer Cement and Concrete** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To familiarize with the basic chemistry, structure, and reactions of geopolymer formation and its reaction products
2. To understand the fundamentals of Geopolymer composites (resins, pastes, mortars, concretes) and their characterization using different advanced analytical tools
3. To study the characteristic properties of Geopolymer composites such as strength, durability, waste utilization, safe disposal of hazardous effluents and heavy metal encapsulations
4. To identify and evaluate various geopolymer systems for commercially viable practical applications in various fields such as infrastructure, nuclear, constructions, buildings, precast systems, strengthening/retrofitting operations, and thermal/fire resistances
5. To analyse the Geopolymer composites with reference to ecology, economy, sustainability and environmental friendliness
6. To gain about toxic waste management

COURSE OUTCOMES:

On completion of the course, the students will be able to:

1. Understand the concepts of basic chemistry, structure, and reactions of geopolymer formation and its reaction products
2. Understand the fundamentals of Geopolymer composites and their characterization
3. characteristic properties of Geopolymer composites such as strength, durability, waste utilization, safe disposal of hazardous effluents and heavy metal encapsulations
4. Identify and evaluate various geopolymer systems for commercially viable practical applications.
5. Analyse the Geopolymer composites with reference to ecology, economy, sustainability and environmental friendliness
6. Will gain the knowledge about toxic waste management

UNIT I - POLYMERS AND GEOPOLYMERS

Introduction - The mineral polymer concept: silicones and geopolymers - Macromolecular structure of natural silicates and alumino silicates - Scientific Tools, X-rays, FTIR, NMR – Poly (siloxonate) and polysilicate, soluble silicate,Si:Al=1:0 - Chemistry of (Na,K)–oligo-sialates: hydrous alumino-silicate gels and zeolites - Kaolinite / Hydrosodalite based geopolymer, poly(sialate) with Si:Al=1:1 - MetakaolinMK-750 based geopolymer, poly(sialate-siloxo) with Si:Al=2:1- Chemical mechanism: formation of ortho-sialate (OH)3-Si-O-Al- (OH)3 –

UNIT II - GEOPOLYMERS AND TOXIC WASTE MANAGEMENT

Calcium based geopolymer, (Ca, K, Na)-sialate, Si:Al=1, 2, 3 - Silica-based geopolymer, sialate link and siloxo link in poly(siloxonate) Si:Al>5 - Fly ash-based geopolymer - Phosphate-based geopolymers - Organic-mineral geopolymer - Containment with barriers - Waste encapsulation

requires MK-750-based geopolymers - Heavy metals in mine tailings - The use of geopolymers for paint sludge disposal - Treatment of arsenic-bearing wastes - Uranium mining waste treatment - Geopolymers in other toxic-radioactive waste management applications

UNIT III - PROPERTIES AND APPLICATIONS

Physical properties of condensed geopolymers - Chemical Properties of condensed geopolymers - Long-term durability, archaeological analogues, geological analogues - Quality control - Development of user-friendly systems – Castablegeopolymer, industrial and decorative applications - Geopolymer – fiber composites - Foamed geopolymer - Geopolymers in ceramic processing

UNIT IV - GEOPOLYMER CEMENT

The manufacture of geopolymer cements - Greenhouse CO2 mitigation fosters the development of geopolymer cements - Additional Raw-Materials from industrial wastes - Additional Raw-Materials from industrial wastes - Replacement of (Na,K) soluble silicates with synthetic lavas

UNIT V - GEOPOLYMER CONCRETE

Geopolymer concrete - Mixture proportions of fly ash-based geopolymer concrete - Mixing, casting, and compaction of fly ash-based geopolymer concrete - Curing of fly ash-based geopolymer concrete - Design of fly ash-based geopolymer concrete mixtures - Short-term properties of fly ash-based geopolymer concrete - Long-term properties of fly ash-based geopolymer concrete - Reinforced geopolymer concrete beams and columns - Better than Portland cement concrete

Suggested Readings

1. J L Provis J S J van Deventer , “Geopolymers”, 1st Edition, Woodhead Publishing,(2009).
2. Joseph DavidovitsGeopolymer Chemistry and Applications,Institute Géopolymère , 16 rue Galilée , France, (2011).
3. Advanced concrete technology by Zongjin li , John – Wily & sons , New Jersey
4. Innovative Material for concrete construction – ACES workshop by Michael N.Fardis, Springer Publications, London, New York

22RCE317 **Pavement Engineering** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

1. To understand the importance of transportation and characteristics of road transport
2. To know about the history of highway development, surveys and classification of roads
3. To study about the geometric design of highways
4. To study about traffic characteristics and design of intersections
5. To know about the pavement materials and design
6. To design flexible and rigid pavements as per IRC.

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Carry out surveys involved in planning and highway alignment.
2. Design cross section elements, sight distance, horizontal and vertical alignment.
3. Implement traffic studies, traffic regulations and control, and intersection design.
4. Determine the characteristics of pavement materials.
5. Design flexible and rigid pavements as per IRC.
6. Will gain the knowledge of horizontal and vertical curves

UNIT I - BASIC CONCEPTS

Pavements types – Historical developments - Approaches to pavement design –vehicle and traffic considerations – behaviour of road materials under repeatedloading – Stresses and deflections in layered systems.

UNIT II - FLEXIBLE PAVEMENT

Factors affecting flexible pavements – material characterization for analyticalpavement design – CBR and stabilometer tests – Resilient modulus – Fatiguesubsystem – failure criteria for bituminous pavements – IRC design guidelines.

UNIT III - RIGID PAVEMENT

Factors affecting rigid pavements - Design procedures for rigid pavement – IRC guidelines – Airfield pavements.Highway pavements – CRC pavements.

UNIT IV - PAVEMENT EVALUATION AND REHABILITATION

Pavement evaluation and rehabilitation, condition and evaluation surveys causes and types of distress – in flexible and rigid pavements – PSI models – Serviceability indexof rural roads – Overlay design, pavements maintenance management and construction.

UNIT V - STABILIZATION OF SOILS FOR ROAD CONSTRUCTIONS

The need for a stabilized soil – Design criteria and choice of stabilizers – Testing and field control – Stabilisation in India for rural roads – Use of Geosynthetics in road construction - Case studies.

Suggested Readings

1. Wright, P.H, Highway Engineers, John Wiley & Sons, Inc., New York, (1996).
2. Khanna S.K and Justo C.E.G, Highway Engineering, Eighth Edition, New Chand and Brothers, Roorkee, (2001).
3. Yoder R.J and WitchakM.W, Principles of Pavement Design, John Wiley, (2000).
4. Croney, D, Design and Performance of Road Pavements, HMO Stationary Office, (1979).
5. Design and Specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, (2001).
6. Guidelines for the Design of Flexible Pavements, IRC:37 - 2001, The Indian roads Congress, New Delhi.
7. Guideline for the Design of Rigid Pavements for Highways, IRC:58-1998, The Indian Roads Congress, New Delhi.
8. O' Flaherty, C.A, Highway Engineering (Vol. 2), Edward Arnold Cp, (1978).
9. Bell. P.S, Developments in Highway Engineering, Applied Sciences publishers, (1978).

22RCE318 Sustainable Solid Waste collection and Management 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 Marks External: 100 Total: 100
End Semester Exam: 3 Hours

Course Objectives:

1. To gain a brief knowledge on different hazardous waste and its disposal methods.
2. To provide students with the necessary background and knowledge about the various sources.
3. To know the on-site/off-site processing of the Solid waste management and the disposal methods.
4. To characterize the waste and its sources with various test available for checking the quality.
5. To impart knowledge and skills in various components of Municipal Solid Waste Management.
6. To gain the knowledge of processing and conversion technologies.

Course Outcomes:

1. Brief knowledge on different hazardous waste and its disposal methods.
2. The necessary background and knowledge about the various sources.
3. The on-site/off-site processing of the Solid waste management and the disposal methods.
4. Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of materials and energy from waste.
5. Have an overview of the Indian and international waste management regulations and guidelines for the design, construction, operation and management of waste treatment facilities.
6. Ways of operation of collection, transfer, treatment, management and disposal of wastes as per Solid Waste Management Rules, 2016.

UNIT I- INTRODUCTION

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management – Elements of integrated waste management and roles of stakeholders - Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, lead acid batteries, plastics and fly ash.

UNIT II - WASTE CHARACTERISATION AND SOURCE REDUCTION

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and characterization plan - Source reduction of wastes – Recycling and reuse – Waste exchange.

UNIT III - STORAGE, COLLECTION AND TRANSPORT OF WASTES

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport

UNIT IV- WASTE PROCESSING TECHNOLOGIES

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes

UNIT V - WASTE DISPOSAL

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – closure of landfills – landfill remediation.

Suggested Readings

1. M. N. Rao, Razia Sultana, " Solid and Hazardous Waste Management" Second Edition, BS Publications, (2020).
2. S. Bhatia , "Solid and Hazardous Waste Management", BS Publications,(2007)
3. M. N. Rao & Razia Sultana, "Solid and Hazardous Waste Management", Second Edition, BS Publications (2020).
4. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, McGraw- Hill International edition, New York, (1993).
5. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, (2000).

22RCE319 Remote Sensing / Spatial Information Technology 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 Marks External: 100 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVE:

1. To gain a sound fundamental understanding of the GIS and remote sensing technologies
2. To understand the basic principles underlying the GIS/model-based management of water resources and environment.
3. To become familiar with the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
4. Different types of remotely sensed images and data available for water resource applications.
5. To apply the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
6. To develop a project report and can develop Water Resource Information Systems (WRIS) for regional and basin scale.

COURSE OUTCOMES

By the end of this course the students will be able to

1. Develop fundamental understanding of the GIS and remote sensing technologies
2. Understand the basic principles underlying the GIS based management of water resources and environment.

3. Apply the GIS-based analytical and problem-solving techniques for sustainable planning and management of water resources and environmental problems.
4. Understand the types of remotely sensed images and data available for water resource applications.
5. Develop a project report and can develop Water Resource Information Systems (WRIS) for regional and basin scale.
6. Understand the basic principles underlying the GIS/model-based management of water resources and environment.

UNIT I -FUNDAMENTALS OF REMOTE SENSING

Introduction to remote sensing – Principles of Electro – Magnetic Radiation – Energy / Matter interaction with Atmosphere and land surface – spectral reflectance of earth Materials and vegetation – Data products

UNIT II - AERIAL PHOTOGRAPHY AND SATELLITE REMOTE SENSING

Aerial Photography – photogrammetry And Visual Image Interpretation –Various Satellites in orbit and their sensors – Resolutions - Multispectral Remote Sensing System (MSS) and design – VISIBLE – NIR remote sensing – Thermal IR Radiation Properties, systems and application – Microwave and LIDAR remote sensing – Principles and applications

UNIT II - DATA ANALYSIS AND GIS

Data Analysis – Visual interpretation and digital image processing – Classification -Introduction to GIS, concepts and base structure , various GIS software.

UNIT IV - REMOTE SENSING AND GIS APPLICATIONS

Application of Remote sensing and GIS – Management and Monitoring of Land, air ,Water and pollution studies – conservation of resources – coastal zone management – Limitations

UNIT V - LABORATORY PRACTIES

Data sources - Visual interpretation - digital image processing –Introduction to ENVI image processing software – GIS / Data Analysis in ARC GIS.

Suggested Readings

1. Anji Reddy , "Remote Sensing and Geographical Information system ", B S Publications, (2001).
2. M.G. Srinivas, "Remote sensing applications", Narosa publishing House, (2001).
3. A M. Chandra and S.k .Ghosh, "Remote Sensing and Geographical Information System", Narosa Publishing House, (2006).
4. Lintz, J. andSimonet,Remote Sensing of Environment, Addison Wesle Publishing Company, (1994).
5. Burro ughs,P.A, Principles of Geographical Information system , Oxford UniversityPress, (1998).
6. Thomas M Lille sand, Rupiah W.Kiefer& Jonathan W. Chip man "Remote sensing and Image Interpretation" John Wiley Sons, (2004).

22RCE320 Groundwater Modeling And Management 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 Marks External: 100 Total: 100
End Semester Exam: 3 Hours

COURSE OBJECTIVE:

1. These courses are introduced to the students to understand the basic concept of mathematical modelling
2. To know about the process simulation techniques of environmental disturbances
3. To know about modeling concept and transport phenomena.
4. To understand ground water prospecting.
5. To understand the contaminant transport model in environment.
6. To gain the knowledge about the ground water flow model.

Course Outcomes:

At the end of this course students can

1. Understand the basic concept of mathematical modelling
2. Know about the process simulation techniques of environmental disturbances with groundwater domains.
3. Concept of modeling concept and transport phenomena.
4. Understand ground water flow model.
5. Understand the ground water prospecting understand the contaminant transport model in environment.
6. Know the importance of Subsurface mass transport through the vadose zone.

UNIT I - GROUNDWATER PROSPECTING

Investigation and evaluation – Geophysical methods- Electrical Resistivity methods – Interpretation of data – Seismic method – Subsurface investigation – Test drilling – Resistivity logging – Application of remote sensing techniques.

UNIT II - GROUNDWATER FLOW MODEL

Physical models – Analog models – Mathematical modeling – Unsaturated flow models Numerical modeling of groundwater flow – Finite Differential equations - Finite difference solution – Successive over Relaxation, Alternating direction implicit procedure – Crank Nicolson equation – Iterative methods -Direct methods - Inverse problem – Finite element method

UNIT III - CONTAMINANT TRANSPORT MODEL

Contaminant transport theory – Advection, dispersion equation – Longitudinal and transverse dispersivity – Hydrodynamic dispersion – Analytical models – Numerical simulation of solute transport – Solution methods - Sorption model – Subsurface mass transport through the vadose zone - Density driven flow - Heat transport.

UNIT IV - MODEL DEVELOPMENT

Data requirements – Conceptual model design : Conceptualization of aquifer system – Parameters, Input-output stresses, Initial and Boundary conditions - Model design and execution : Grid design, Setting boundaries, Time discretization and Transient simulation – Model calibration : steady state and unsteady state – sensitivity analysis – Model validation and prediction – Uncertainty in the model prediction

UNIT V - GROUNDWATER MANAGEMENT MODEL

Optimal groundwater development – Indian GEC norms – Conjunctive use models Modeling multilayer groundwater flow system -Modeling contaminant migration – Modeling fracture flow

system – Artificial recharge feasibility through modeling – Simulation of movements of solutes in unsaturated zone – Stochastic modeling of groundwater flow - Groundwater contamination, restoration and management

Suggested Readings

1. Anderson M.P., and Woessner W.W, Applied Groundwater Modelling : Simulation of flow and advective transport, Academic Press, Inc, (2000).
2. Fetter C.W, Contaminant Hydrogeology, Prentice Hall, (2008).
3. Rushton K.R, Groundwater Hydrology:Conceptual and Computational Models, Wiley, (2003).
4. Elango L. and Jayakumar, R., Modelling in Hydrology, Allied Publishers Ltd, (2001).
5. Remson I., Hornberger G.M. and MoltzF.J, Numerical Methods in Subsurface Hydrology, Wiley, New York, (2007).
6. Robert Willis and William W.G.Yenth, Groundwater System Planning and Management, Prentice Hall, Englewood Cliffs, (1987).
7. M. Thangarajan, Vijay P. Singh,Groundwater Assessment, Modeling, and Management, CRC Press Custom Publishing, (2016).

22RCE321 Advanced Treatment Techniques for industrial Wastewater 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

Course Objectives:

1. To learn various process engineering, unit operations of Mining, Metallurgical, Thermal Power, Cement and Petroleum Industries.
2. Provides a fundamental understanding of the design, operational principles and practical applications of modern instrumental methods employed in chemical analysis of environmental samples.
3. To have a basic knowledge about Source reduction techniques.
4. To understand the concept of wastewater reuse and residual management
5. To understand detailly about Disposal on water and land
6. To gain the knowledge about the pollution prevention of assessment.

Course Outcomes:

At the end of this course students can

1. Understanding the environmental aspects and impacts of each unit operations of the polluting industries.
2. The students will be able to understand and orient themselves with the industry before they undergo summer training, internship, interview or job.
3. The students will be able to conceive and prepare Environmental Management Plan of these industries.
4. Develop critical thinking skills in the areas of instrument selection, method development and data interpretation.
5. Knowledge in various case studies about various industries.
6. Able to get a detailed Regulatory requirement for treatment of industrial wastewater.

UNIT I - INTRODUCTION

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management

UNIT II - INDUSTRIAL POLLUTION PREVENTION

Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Pollution Prevention of Assessment - Material balance - Evaluation of Pollution prevention options –Cost benefit analysis – pay back period - Waste minimization Circles

UNIT III - INDUSTRIAL WASTEWATER TREATMENT

Equalization - Neutralization – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – carbon adsorption – Photo-catalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.- Treatability studies.

UNIT IV - WASTEWATER REUSE AND RESIDUAL MANAGEMENT

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse, Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

UNIT V - CASE STUDIES

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries.

Suggested Readings

1. Eckenfelder, W.W, Industrial Water Pollution Control, Mc-Graw Hill, (2000).
2. Nelson Leonard Nemerow, Industrial waste treatment contemporary practice and vision for the future, Elsevier, Singapore, (2007).
3. Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, (2001).
4. Paul L. Bishop, Pollution Prevention: - Fundamentals and Practice, Mc-Graw Hill International, Boston, (2000).
5. Dezotti**,** Márcia, Lippel**,** Geraldo, Bassin**,** João Paulo- Advanced Biological Processes for Wastewater Treatment, Springer International Publishing, (2018).
6. MogensHenze, PoulHarremoes, Erik Arvin, Jes LaCour Jansen, "Wastewater Treatment" Springer-Verlag Berlin Heidelberg, (2017).

22RCE322 **Environmental Policies and Legislations** **4H- 4C**

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**

End Semester Exam: 3 Hours

Course Objectives:

1. Understating the environmental laws, acts, standard for environmental compliance.
2. Understating the EIA and its methodologies for Industries and Regulators.
3. To learn methodologies of Environmental Management System through Appellate Authority – Penalties for violation of consent conditions
4. To learn the implementation of Environmental Management System through Environmental Audits.
5. Insight of regulatory framework related to hazardous waste management.
6. To have a knowledge about the air act, water act and environmental act.

Course Outcomes:

At the end of this course students can learn the

1. Concepts and applications of Environmental Laws and EIA in real world situations
2. Environmental management system and various auditing processes.
3. Prepare the statutory Environmental Statement for various industries.
4. Serve and guide the industrial sector as good corporate citizens.
5. Understanding the principles of regulatory framework for the treatment and disposal of hazardous wastes.
6. Knowledge about the Concept of absolute liability.

UNIT I - INTRODUCTION

Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration – Environmental Protection Act, Water (P&CP) Act, Air (P&CP) Act – Institutional framework (SPCB/CPCB/MoEF)

UNIT II - WATER (P&CP) ACT, 1974

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT III - AIR (P&CP) ACT, 1981

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

UNIT IV- ENVIRONMENT (PROTECTION) ACT 1986

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

UNIT V- OTHER TOPICS

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

Suggested Readings

1. CPCB,"Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, (1997).
2. Shyam Divan and Armin Roseneranz,"Environmental law and policy in India "Oxford University Press, New Delhi, (2001).
3. Pollution control Legislations volume I &II issued by Tamil Nadu Pollution Control Board.

22RCE323 CONSTRUCTION PROJECT MANAGEMENT 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

Course Objectives:

1. To study the various management techniques for successful completion of construction
2. To study the effect of management for project organization
3. To understand a design of construction process.
4. To understand about the labour, material and equipment utilization
5. To learn about the application of cost indices and cost estimation in the construction
6. To gain the knowledge about the Estimation of operating cost

Course Outcomes:

At the end of this course students can

1. Understanding the various management techniques and Role of Project Managers
2. The students will be able to understand modern trends in project management
3. The students will be able to Design and Construction as an Integrated System
4. Develop critical thinking skills in the areas of problems in construction management, Choice of Equipment and Standard Production Rates
5. Knowledge in various Construction Processes Queues and Resource Bottlenecks.
6. Able to get a detailed knowledge in resource unitlisation and cost estimation.

UNIT I THE OWNERS' PERSPECTIVE - Introduction - Project Life Cycle - Types of Construction - Selection of Professional Services - Construction Contractors - Financing of Constructed Facilities - Legal and Regulatory Requirements - Changing Environment of the Construction Industry - Role of Project Managers.

UNIT II ORGANIZING FOR PROJECT MANAGEMENT - Project Management – modern trends - Strategic Planning - Effects of Project Risks on Organization - Organization of Project Participants -Traditional Designer-Constructor Sequence - Professional Construction Management - Owner-Builder Operation - Turnkey Operation -Leadership and Motivation for the Project Team.

UNIT III - DESIGN AND CONSTRUCTION PROCESS - Design and Construction as an Integrated System - Innovation and Technological Feasibility - Innovation and Economic Feasibility - Design Methodology - Functional Design - Construction Site Environment.

UNIT IV - LABOUR, MATERIAL AND EQUIPMENT UTILIZATION - historical Perspective - Labour Productivity - Factors Affecting Job-Site Productivity - Labour Relations in Construction - Problems in Collective Bargaining - Materials Management - Material Procurement and Delivery - Inventory Control - Tradeoffs of Costs in Materials Management. - Construction Equipment - Choice of Equipment and Standard Production Rates - Construction Processes Queues and Resource Bottlenecks.

UNIT V - COST ESTIMATION - Costs Associated with Constructed Facilities - Approaches to Cost Estimation - Type of Construction Cost Estimates - Effects of Scale on Construction Cost - Unit Cost Method of Estimation - Methods for Allocation of Joint Costs - Historical Cost Data - Cost Indices - Applications of Cost Indices to Estimating - Estimate Based on Engineer's List of Quantities - Estimation of Operating Costs.

REFERENCE BOOKS:

1. Prasanna Chandra " Project Planning,Analysis, Selection, Implementation and review" Tata Mcgraw Hill ,1999
2. Chitkara, K.K Construction Project Management: Planning Scheduling and control Tata McGraw-Hill Publishing Company, New Delhi- 1998
3. Frederick E. Gould, Construction Project Management, Went worth Institute of Technology,Vary E. Joyce, Massachusetts Institute of Technology, 2000
4. Choudhury, S Project Management, Tata McGraw-Hill Publishing company New Delhi 1988.
5. Sengutha,B., Guha,H., " Construction Management and Planning ", TataMcGraw Hill,2001

22RCE324 TRAFFIC ENGINEERING AND MANAGEMENT 4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0 **Marks External: 100** **Total: 100**
End Semester Exam: 3 Hours

Course Objectives:

1. To have an overall knowledge of the traffic components and assess the traffic characteristics and related problems.
2. To develop a strong knowledge base of traffic planning and its management in anytransportation area.
3. To provide knowledge of traffic control devices and its techniques in transportationinteraction.
4. To understand the concept of wastewater reuse and residual management
5. To understand the geometric design of intersections
6. To gain the knowledge about the Traffic Management.

Course Outcomes:

At the end of this course students can

1. The students will gain knowledge in the fundamentals components of traffic engineering and its features.
2. The students will get a vast understanding on various traffic enforcements rules and regulations.
3. The students will get aware in the field of transportation andits utility in solving the traffic problems.
1. Understanding in geometric design of intersections
2. Able to understand about the Traffic Management System.

UNIT I - INTRODUCTION

Significance and scope, Characteristics of Vehicles and Road Users, Skid Resistance and Braking Efficiency (Problems), Components of Traffic Engineering- Road, Traffic and Land Use Characteristics

UNIT II - TRAFFIC SURVEYS AND ANALYSIS

Surveys and Analysis - Volume, Capacity, Speed and Delays, Origin and Destination, Parking, Pedestrian Studies, Accident Studies and Safety Level of Services- Problems

UNIT III - TRAFFIC CONTROL

Traffic signs, Road markings, Design of Traffic signals and Signal co-ordination (Problems), Traffic control aids and Street furniture, Street Lighting, Computer applications in Signal design

UNIT IV - GEOMETRIC DESIGN OF INTERSECTIONS

Conflicts at Intersections, Classification of Intersections at Grade, - Chanallised and Unchanallised Intersection - Grade Separators (Concepts only), Principles of Intersection Design, Elements of Intersection Design, Chanallisation and Rotary design (Problems), Grade Separators

UNIT V - TRAFFIC MANAGEMENT

Traffic Management- Traffic System Management (TSM) and Travel Demand Management (TDM), Traffic Forecasting techniques, Restrictions on turning movements, One-way Streets, Traffic Segregation, Traffic Calming, Tidal flow operations, Exclusive Bus Lanes - Introduction to Intelligence Transport System (ITS)

REFERENCES:

1. Indian Roads Congress (IRC) specifications: Guidelines and special publications on Traffic Planning and Management**.**
2. Guidelines of Ministry of Road Transport and Highways, Government of India.
3. Subhash C.Saxena,(2009), A Course in Traffic Planning and Design, Dhanpat Rai Publications, New Delhi.
4. Khanna K and Justo C E G(2001), Highway Engineering, ***Khanna Publishers, Roorkee.***
5. KadiyaliL(2000), *Traffic Engineering and Transport Planning.Khanna Technical Publications, Delhi.*