

# **Ph.D CIVIL ENGINEERING CURRICULUM & SYLLABI 2020 -2021**

**Department of Civil Engineering  
Faculty of Engineering**



**KARPAGAM ACADEMY OF HIGHER EDUCATION**

(Deemed to be University Established Under Section 3 of UGC Act 1956)

COIMBATORE 641 021. INDIA.

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

Subject Code	Paper I	Instruction Hours / week	Credits	Max Marks (100)	Page Number
20RCE101	Paper- I: Research Methodology and Pedagogy	4	4	100	03
20RCE201	Paper- II: Research Publication Ethics	4	4	100	05
20RCE301	Paper- III: Advanced Environmental Engineering	4	4	100	07
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Program Total		12	12	300	

19RCE101

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

**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, (1996), 'The Craft of Scientific Writing', 3<sup>rd</sup> Edition, Springer.
2. Alley, Michael, (2003), 'The Craft of Scientific Presentations', Springer.

### **Reference Books**

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

### **Websites:**

[www.english4engineer.com](http://www.english4engineer.com)

[www.learn4good.com/language/engineer](http://www.learn4good.com/language/engineer)

20RCE201

Research Publication Ethics

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**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.

20RCE201

Advance Structural Engineering

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**UNIT I - MATERIAL SCIENCE FOR CIVIL ENGINEERING**

Modern concrete and concreting techniques, advanced concrete materials, composites, laminates and its applications. Reinforced Concrete and Pre-stressed concretes, Concepts and design, Codal provisions system, optical networking, satellite communication system.

**UNIT II - FINITE ELEMENT METHOD**

Finite Element Method, 2D and 3D applications in plane and three dimensional elasticity problems. Analysis of plate and shell structures. Applications using proper software. Nonlinear analysis of structural elements. Material and geometric nonlinearity. Applications for beam, plates and shells.

**UNIT III - DESIGN OF FLAT SLAB AND GRID FLOORS :**

Yield line theory of slabs – Hillerberg's method of design of slab – Design of Flat- Slab Equivalent frame method of design - Approximate analysis and Design of grid floors.

**UNIT IV - MEMBRANE THEORY OF SHELLS**

Classification of shells - Types of shells - Structural action - Membrane theory – Shells of revolution and shells of translation - Examples - Limitations of membrane theory.

**UNIT V - MODEL ANALYSIS**

Laws of similitude - model materials – model testing – testing large scale structures – holographic techniques

**Suggested Readings**

1. S.P. Timoshenko and Goodier (2011), 3rd ed., international student edition, Theory of Elasticity, McGraw – Hill Publications.
2. Devdas Menon, (2009), Advance Structural Engineering, Alpha Science Intl Ltd .
3. Anil K Chopra, (2011), Dynamics of Structures Theory and Applications to Earthquake Engineering, 4<sup>th</sup> Edition, Prentice – Hall Publications
4. R.W. Clough and J Penzin – Dynamics of Structures , McGraw Hill Publications
5. R.C. Roy – Structural Dynamics an Introduction to computer methods, John wiley & Sons Publications
6. S. Timoshenko and W. Krieger, Theory of plates and shells, McGraw Hill
7. Ansel C. Ugural, Stresses in plates and shells, McGraw Hill
8. Chadrashekhara K. Analysis of Plates , New Age International Edition
9. J.N. Reddy – An Introduction to the finite element method – Tata McGraw Hill Publishing Co. Lt

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



20RCE203

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

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

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

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

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**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.

Empirical 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.(2000), "Dynamics soil tests and applications", Wheeler Publishing, New Delhi,
2. Prakash, S and Puri, V.K.,(1987), " Foundations for machines", McGraw Hill.
3. Moore, P.J., (1985), "Analysis and Design of Foundations for Vibrations", Oxford and IBH.
4. Vaidyanathan, C.V., and Srinivasalu, P.,(1995), Handbook of Machine Foundations, McGraw Hill.
5. KameswaraRao,(1998) "Vibration Analysis and Foundation Dynamics", Wheeler Publishing, New Delhi..
6. Swami Saran,(2010), "Soil Dynamics and Machine Foundation", Galgotia publications Pvt. Ltd. New Delhi.
7. Das B.M., (1992), "Principles of Soil Dynamics", McGraw Hill.
8. Krammer S.L.,(2004), "Geotechnical Earthquake Engineering", Prentice Hall, International series, Pearson Education (Singapore) Pvt Ltd.

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

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

20RCE208

Soil Structure Interaction

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

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

20RCE209

Reinforced Soil Structures

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

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

20RCE210

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

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



20RCE211

Experimental Stress Analysis

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**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, Wheatstone 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., and Ramachandra, K., (1984), “Experimental Stress Analysis”, Tata McGraw-Hill, New Delhi.

**References**

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

20RCE212

Rehabilitation and Modernisation of Irrigation Systems

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

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

20RCE301

Advanced Concrete Technology

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

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

20RCE302

Prefabricated Structures

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

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

20RCE303

High Performance Concrete

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

**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 chart 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 inhibitors – water, mixture proportioning – constructability, serviceability, quality control and quality assurance

**UNIT V – ECONOMICS OF HPC & HPC in 21<sup>st</sup> 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 ,2<sup>nd</sup> edition John Wiley & 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( 2002) High performance concrete performance and quality of concrete structures ,Proceedings of the 3<sup>rd</sup> international conference .

20RCE304

Ground Improvement Techniques

4H- 4C

Instruction Hours / Week: L: 4 T: 0 P: 0

Marks External: 100

Total: 100

End Semester Exam: 3 Hours

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

20RCE305

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

**UNIT I - POLYMERS AND GEOPOLYMERS**

Introduction - The mineral polymer concept: silicones and geopolymers - Macromolecular structure of natural silicates and aluminosilicates - Scientific Tools, X-rays, FTIR, NMR – Poly (siloxonate) and polysilicate, soluble silicate, Si:Al=1:0 - Chemistry of (Na,K)-oligo-sialates: hydrous aluminosilicate 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)<sub>3</sub>-Si-O-Al- (OH)<sub>3</sub> –

**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 CO<sub>2</sub> 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. Joseph Davidovits( 2011), Geopolymer Chemistry and Applications ,Institute Géopolymère , 16 rue Galilée , France.
2. Advanced concrete technology by Zongjinli , John – Wily & sons , New Jersey
3. Innovative Material for concrete construction – ACES workshop by Michael N.Fardis, Springer Publications, London, New York
4. Dr. P. PurushothamaRaj , “Ground Improvement Techniques”,Laxmi Publications , New delhi.

**UNIT I - BASIC CONCEPTS**

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

**UNIT II - FLEXIBLE PAVEMENT**

Factors affecting flexible pavements – material characterization for analytical pavement design – CBR and stabilometer tests – Resilient modulus – Fatigue subsystem – 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 index of 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(1996), Highway Engineers, John Wiley & Sons, Inc., New York.
2. Khanna S.K and Justo C.E.G(2001), Highway Engineering, Eighth Edition, New Chand and Brothers, Roorkee.
3. Yoder R.J and Witchak M.W(2000)., Principles of Pavement Design, John Wiley.
4. Croney, D(1979), Design and Performance of Road Pavements, HMO Stationary Office.
5. Design and Specification of Rural Roads (Manual),( 2001), Ministry of rural roads, Government of India, New Delhi.
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 (1978), Highway Engineering (Vol. 2), Edward Arnold Cp.
9. Bell. P.S(1978), Developments in Highway Engineering, Applied Sciences publishers.



**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. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, (1993), “Integrated Solid Waste Management, McGraw- Hill International edition, New York.
2. CPHEEO (2000), “Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi.

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**20RCE308 Remote Sensing and GIS Applications in Environmental Engineering 4H- 4C**

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

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

**Suggested Readings**

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

20RCE309

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

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

7. M. Thangarajan, Vijay P. Singh,(2016), Groundwater Assessment, Modeling, and Management, CRC Press Custom Publishing.

**Part III :Ph.D in Civil Engineering**

**2020-21**

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**20RCE310 Industrial Wastewater Pollution -Prevention and Control 4H- 4C**

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**Instruction Hours / Week: L: 4 T: 0 P: 0**

**Marks External: 100**

**Total: 100**

**End Semester Exam: 3 Hours**

### **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 (2000) Industrial Water Pollution Control, Mc-Graw Hill.
2. Nelson Leonard Nemerow (2007), Industrial waste treatment contemporary practice and vision for the future, Elsevier, Singapore.
3. Frank Woodard (2001), Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi.
4. Paul L. Bishop (2000) Pollution Prevention: - Fundamentals and Practice, Mc-Graw Hill International, Boston.
5. Dezotti, Márcia, Lippel, Geraldo, Bassin, João Paulo (2018) - Advanced Biological Processes for Wastewater Treatment, Springer International Publishing.

6. MogensHenze, PoulHarremoes, Erik Arvin, Jes LaCour Jansen (2017), “Wastewater Treatment” Springer-Verlag Berlin Heidelberg.

**Part III :Ph.D in Civil Engineering**

**2020-21**

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**20RCE311**

**Environmental Policies and Legislations**

**4H- 4C**

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**Instruction Hours / Week: L: 4 T: 0 P: 0**

**Marks External: 100**

**Total: 100**

**End Semester Exam: 3 Hours**

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