Minor Degree Courses offered

by

Department of Civil Engineering

(For B.Tech. Students of other departments from session 2025-26)

1. For holistic development of the students and as per NEP-2020 and AICTE guideline, the students may earn additional 20 credits through the minor degree courses offered by different departments of the University from Semester IV to VIII.
2. Minor degree courses are optional, but it will be helpful to align the need of industries.
3. Students can only opt for one minor degree course during his/her studies of the B. Tech. program
4. If students complete all 5 PE (professional elective) category courses offered for the minor degree (total 20 credit) from the other department for minor degree, he/shell get a B. Tech. degree in his/her own branch.
5. No extra fee for a minor degree course will be charged by the students
6. In case if a student is unable to complete all 5 PE courses as offered by the other department for minor degree at the time of completion of B. Tech. program in his/her own branch then student will get B. Tech. degree in his/her own branch without completing the minor degree course from other Department.
7. The minor degree course may be offered by the department through MOOC, as per the guidelines in B. Tech. ordinance 3.0 for the MOOC course.

The department of Civil Engineering offers the following minor degree courses for the students of undergraduate B. Tech. program of other departments:

Minor Degree courses (MDC)

Minor Degree 1: Structural Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE -101	Matrix Method of Analysis	3	1	0	4
PE3	ECE -301	Structural Dynamics	3	1	0	4
PE5	ECE -501	Repair and Retrofitting of Structures	3	1	0	4
PE7	ECE -701	Advance Concrete Technology	3	1	0	4
PE9	ECE -901	Seismic Design of Structures	3	1	0	4
					Total	20

Minor Degree 2: Geotechnical Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	

PE1	ECE -102	Geotechnical Investigations and Field Testing of Soil	3	1	0	4
PE3	ECE -302	Advanced Foundation Engineering	3	1	0	4
PE5	ECE -502	Geotechnical Earthquake Engineering	3	1	0	4
PE7	ECE -702	Earth And Earth Retaining Structures	3	1	0	4
PE9	ECE -902	Foundation on Expansive Soil	3	1	0	4
					Total	20

Minor Degree 3: Environmental Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE -103	Global Warming and Climate Change	3	1	0	4
PE3	ECE -303	Environmental Planning and Management	3	1	0	4
PE5	ECE -503	Environmental Laws and Policy	3	1	0	4
PE7	ECE -703	Environmental Change and Sustainable Development	3	1	0	4
PE9	ECE -903	Environmental Chemistry and Microbiology	3	1	0	4
					Total	20

Minor Degree 4: Transportation Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE -104	Principles of Highway Engineering	3	1	0	4
PE3	ECE -304	Railway and Airport Engineering	3	1	0	4
PE5	ECE -504	Highway Geometric Design	3	1	0	4

PE7	ECE -704	Intelligent Transportation System	3	1	0	4
PE9	ECE -904	Traffic Engineering	3	0	2	4
					Total	20

Minor Degree 5: Water Resources Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE-105	Engineering Hydrology	3	1	0	4
PE3	ECE-305	Soil Water Conservation	3	1	0	4
PE5	ECE-505	Groundwater Hydrology	3	1	0	4
PE7	ECE -705	Water Resources Management	3	1	0	4
PE9	ECE -905	Geoinformatics for Water Resources	3	1	0	4
					Total	20

Minor Degree 6: Geospatial Technology

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE-106	Global Positioning System	3	1	0	4
PE3	ECE-306	Principle of Remote Sensing	3	1	0	4
PE5	ECS-509	Web Technology for GIS & Mapping	3	0	2	4
PE7	ECS-709	Spatial Information Technology	3	1	0	4
PE9	ECS-919	Spatial Data Quality Assessment	3	1	0	4
					Total	20

Minor Degree 1: Structural Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE -101	Matrix Method of Analysis	3	1	0	4
PE3	ECE -301	Structural Dynamics	3	1	0	4
PE5	ECE -501	Repair and Retrofitting of Structures	3	1	0	4
PE7	ECE -701	Advance Concrete Technology	3	1	0	4
PE9	ECE -901	Seismic Design of Structures	3	1	0	4
					Total	20

ECE -101		**Matrix Method of Analysis**
Course category	:	Program Elective-1
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, Minor tests and One Major Theory Examination.
Course Objectives	:	The main objective is to expand the student knowledge of the stiffness and flexibility methods studied in the basic structural analysis courses. This course is also expected to enable a good understanding of how standard software packages and students will be able to implement the method developing their own computer 85 program to analyze structures.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course
1. To understand the basic concepts of structural analysis and matrix algebra. 2. To understand the matrix methods can be applied to plane and space trusses; beams and grids; plane and spaceframes. 3. To identify a suitable system of releases (flexibility method) or an appropriate set of degrees of freedom (stiffness method). 4. To formulate and solve the equilibrium equations (stiffness method) or boundary conditions (flexibility method). 5. Ability to use modern structural analysis software. 6. Able to understand and analysis complex structures.		
Topics Covered		
UNIT-I		9
Introduction to Flexibility and stiffness method. Hand computation of problems on beam.		
UNIT-II		9
Hand computation of problems on trusses, frames and grids.		
UNIT-III		9

Generalized computer-oriented treatment of stiffness method, Method of assembling the stiffness matrix, substructure technique for solving very large structures.	
UNIT-IV	9
Analysis for imposed deformation, temperature, support settlement, etc. Transfer matrix method of analyzing framed structure.	
Textbooks 1.H.C. Matrix, Introduction to Matrix Methods, of structural Analysis, McGraw Hill, New York. **Reference books** 1.Weaver & Gere, Matrix Analysis of Framed structures.	

ECE -301	**Structural Dynamics**	
Course category	:	Programme Elective-3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, Minor tests and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following: knowledge, skills and attitudes after completing this course

1. Relate the structural idealization to properties of realstructure.
2. Able to establish dynamicequilibrium.
3. Able to solve the Eigen value problem and knowledge to itsproperties.
4. To calculate response from different types ofloading.
5. Continuous systems; discretization; soil-structure interaction; seismic design concepts
6. MDOF systems; harmonic excitation; mode superposition; Lagrange's equations

Topics Covered	
UNIT-I	9
Introduction to structural dynamics, definition of basic problem in dynamics, static versus dynamic loads, different types of dynamic loads. Sources of vibration, Degrees of freedom, Single degree of freedom systems: Free vibrations of undamped and viscously damped systems, Raleigh‟s Method, Damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration.	
UNIT-II	9
Structures modelled as shear buildings: Free vibration of shear building; Forced Vibration of Shear Buildings, logarithmic decrement, forced vibration, response to periodic loading, dynamic load factors, response of structure subjected to general dynamic load, Dulhamel‟s integral, numerical evaluation of dynamics response of SDOF systems.	
UNIT-III	9
Multiple degree of Freedom Systems, Response to harmonic excitation, Dynamic Analysis of beams, Dynamic Analysis of plane frames; mode superposition method Lagranges' equations, Eigen value problems; Linear Response of Multi Degree freedom systems.	
UNIT-IV	9

Dynamic analysis of structures with distributed properties, Discretization of continuous systems, Introduction to seismology, effect of soil properties and damping on seismic performance of structure, concept of seismic design of RC Structure
Textbooks/ Reference books 1. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education. 2. Dynamics of Structures, Anil K. Chopra, Prentice Hall, India. 3. Dynamics of Structures, Cloguh & Penzein, Tata McGraw Hill. New Delhi 4. Structural Dynamics, John M. Biggs, Tata McGraw Hill. New Delhi

ECE -501		**Repair and Retrofitting of Structures**
Course category	:	Programme Elective-5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, Minor tests and One Major Theory Examination.
Course Outcomes	:	Students will be able to understand

1. The importance of maintenance and assessment method of distressed structures.
2. The techniques for repair protection methods and understand the properties of repair materials Masonry repair & retrofitting techniques
3. RC retrofitting; base isolation; damping; bridges; heritage structures
4. Repair, rehabilitation and retrofitting of structures and demolition methods.
5. the strength and durability properties, their effects due to climate and temperature.
6. recent development in concrete

Topics Covered	
UNIT-I	9
Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration	
UNIT-II	9
Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, Sulphur infiltrated concrete, ferro cement and polymers coating for rebars loadings from concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels and cathodic protection	
UNIT-III	9
Restoration and Retrofitting; Repair Materials; In-situ testing methods for RC and masonry structure; Techniques of repair and retrofitting of masonry buildings	
UNIT-IV	9
Repair of structures distressed due to earthquake – Strengthening using FRP -Strengthening and stabilization techniques for repair, Engineered demolition techniques for structures -case studies.	
Books & References: 1. Concrete Structures, Materials, Maintenance and Repair- Denison Campbell, Allen and Harold Roper, (Longman Scientific and Technical, UK),1991	

2. Repair of Concrete Structures -Allen R.T and Edwards S.C. (Blakie and Sons, UK),1987
3. Learning from Failures, Deficiencies in Design, Construction and Service-Raikar, R.N., R and D Centre (SDCPL), Raikar Bhavan, Bombay,1987.
4. Concrete Technology-Santha kumar A. R. (Oxford University Press), 2007, Printed in India by Radha Press, New Delhi
5. Concrete Repair and Maintenance Illustrated -Peter H. Emmons (Galgotia Publications Pvt. Ltd.),2001
6. Maintenance and Durability of Concrete Structures-Dayaratnam. P and Rao. R (University Press),1997.

ECE -701		**Advance Concrete Technology**
Course category	:	Programme Elective-7
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1 Able to test all the concrete materials as per IS code design the concrete mix using IS code method
2 Able to determine the properties of fresh and hardened of concrete design special concretes and their specific applications ensure quality control while testing/ sampling and acceptance criteria.
3 Understand limit state design philosophy.
4 Understand the behavior of beam under flexure and shear.
5 Able to design beams using limit state method.
6 Able to design one way slab using limit state method.

Topics Covered

UNIT-I	9

Constituent of concrete, grade of concrete, manufacturing of concrete, importance of water cement ratio, properties of fresh concrete workability, factor affecting workability, consistency, cohesiveness, bleeding, segregation Properties of hard concrete, compressive, tensile and flexure strength, modulus of elasticity, shrinkage and creep.

UNIT-II	9

Mix design for compressive strength by various methods, mix design for flexural strength, Admixtures used in cement concrete. Introduction to Various Design Philosophies, Design of Rectangular Singly and Doubly Reinforced Sections by Working Stress Method. Assumptions in Limit State Design Method, Design of Rectangular Singly and Doubly Reinforced beams, T-beams, L-beams.

UNIT-III	9

Behavior of RC beams in Shear, Shear Strength of beams with and without shear reinforcement, Minimum and Maximum shear reinforcement. Introduction to development length, Anchorage bond, flexural bond, Failure of beam under shear.

UNIT-IV	9

Design of one way and two-way slabs. Serviceability Limit States, Control of deflection, cracking and vibrations. Design of Columns by Limit State Design Method. Effective height of columns, Minimum eccentricity, column under axial compression, requirements for reinforcement, Column with helical reinforcement.

LIST OF EXPERIMENTS

1. Compressive Strength of Concrete. 2. Workability by Compaction Factor, Slump Test. 3. Determination of Constituents of Hardened Mortar. 4. Mix Design by IS Code Method

Textbooks

1. IS : 456 – 2000.
2. Reinforced Concrete – Limit State Design by A. K. Jain, Nem Chand & Bros., Roorkee.

Reference books

1. Plain and Reinforced Concrete Vol. I & II by O. P. Jain & Jai Krishna, Nem Chand & Bros.
2. Reinforced Concrete Structures by R. Park and Pauley.
3. Reinforced Concrete Design by P. Dayaratnam.

ECE -901		**Seismic Design of Structures**
Course category	:	Programme Elective-9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1 To introduce nature and characteristics of various dynamics loads.
2 .To have considerable knowledge of theory of vibrations including multi-degree of freedom systems.
3 To assess of structural failure due to earthquakes.
4 To analyze and design structures subjected to seismic loading as per IS codes.
5 To introduce ductile detailing of structures, concept of soft story and design of shear walls as per IS codes.
6 Understand the concept of base shear, natural time period and natural frequency.

Topics Covered

UNIT-I	9

Seismological background: Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, Richter scale, measurement of ground motion, seismogram

UNIT-II	9

Definitions of basic problems in dynamics, static versus dynamic loads, different types of dynamic loads, un-damped and damped vibration of SDOF system, natural frequency, and periods of vibration, damping in structure, response to periodic loads, response to general dynamic load, response of structure subject to gravitational motion, lumped SDOF elastic systems, translational excitation.

UNIT-III	9

Multi Degree of Freedom Systems Two degree and multi-degree freedom systems lumped MDOF elastic systems, translational excitation time history analysis, multistoried buildings with symmetric plans, multistoried buildings with unsymmetrical plans, combining maximum modal responses using mean square response of a single mode, SRSS and CQCC

combination of modal responses. earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo- acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics.	
UNIT-IV	9
Concepts of Earthquake Resistant Design of Reinforced Concrete Buildings – Earthquake and vibration effects on structure, identification of seismic damages in R.C. buildings, Effect of structural irregularities on the performance of R.C. buildings during earthquakes and seismo- resistant building architecture Seismic Analysis and Modelling of R.C. Buildings: I. S. code method of seismic analysis: seismic co- efficient method and its limitation, response spectrum method, IS: 1893 (Part 1)-2016. seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints as per IS 13920 - 2016, E.R.D. of R.C. building.	
Textbooks 1. Earthquake Resistant Design of Structures - P. Agarwal & M. Shrikhande 2. Structural Dynamics – Theory & Computation - Mario Paz 3. Dynamics of Structures Theory and Applications to Earthquake Engineering - Anil K. Chopra **Reference books** 1. Introduction to Structural Dynamics - J.M. Biggs 2. Elements of Earthquake Engineering - Jai Krishna and A.R. Chandrasekharan 3. Fundamental of Earthquake Engineering - N.M. Neumarks and E. Rosenblueth 4. Engineering Vibrations - L.S. Jacobsen & R.S. Ayre 5. Structural Dynamics - R. Roy Craig Jr. 6. Dynamics of Structures - R.W. Clough & J. Penjien 3. Reinforced Concrete Design by P. Dayaratnam.	

Minor Degree 2: Geotechnical Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE -102	Geotechnical Investigations and Field Testing of Soil	3	1	0	4
PE3	ECE -302	Advanced Foundation Engineering	3	1	0	4
PE5	ECE -502	Geotechnical Earthquake Engineering	3	1	0	4
PE7	ECE -702	Earth And Earth Retaining Structures	3	1	0	4
PE9	ECE -902	Foundation on Expansive Soil	3	1	0	4
					Total	20

ECE-102	**Geotechnical Investigations and Field Testing of Soil**
Course category	Program Elective-1
Pre-requisite Subject	NIL
Contact hours/week	Lecture: 3, Tutorial: 1 , Practical: 0
Number of Credits	4
Course Assessment Methods	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory Examination and Practical Examination
Course Objectives	The objectives of the course are as follows: 1. To Understand the types of soil and develop various applications of soil as a construction material for civil engineering structures. 2. To Evaluate the soil quality to understand the basic relationships between physical and mechanical properties of soils. 3. To understand the soil testing methods as the basic knowledge of classification and engineering properties of soil 4. To understand the different ground modification methods and the experimental methods for laboratory as well as field investigations.
Course Outcomes	After completion of this course the students will be able to demonstrate following

	knowledge, skills and attitudes. 1. Comprehend the basics of site investigation methods and field tests and its extent for variety of structures including preliminary investigations. 2. Identify and suitable investigation method for soil exploration. 3. Illustrate different specialized exploration methods based on condition and requirement. 4. Appraise different codal provisions for field tests. 5. Basic knowledge about soil explorations and field investigations. 6. Learn to prepare soil investigation report.
Topics Covered	
UNIT-I	**9**
Interpretations and Codal Provisions: Soil profiling, interpretation of exploration data and report preparation, various standards for soil investigations. direct, semi-direct, and indirect methods of soil investigations, Purpose and Phases of Soil Investigation. Report writing: Soil exploration Reports- identification, calculations and preparation.	
UNIT-II	**9**
Exploration Methods: Methods of Boring, Augering and Drilling. Machinery used for drilling, types of augers and their usage for various projects. Soil Sampling: sampling methods, types of samples, storage of samples and their transport. Sample preparation, sample sizes, types of samplers specifications for soil testing. Trial pits, disturbed and undisturbed sampling Detailed bore hole investigations: types of borings and types of samplers. Compaction: Standard and Modified Proctor compaction tests; field compaction; Proctor Needle Test. Consolidation test.	
UNIT-III	**9**
Geophysical Investigations: Introduction to geophysical methods, Seismic Refraction Test: Principles and applications, MASW (Multichannel Analysis of Surface Waves) and SASW (Spectral Analysis of Surface Waves) methods, Electrical resistivity test: Principles, methods, and applications, Ground-penetrating radar (GPR) and magnetic surveys, Seismic Refraction methods.	
UNIT-IV	**9**
Field Tests: Methods and specifications – visual identification tests, vane shear test, penetration tests, analysis of test results. Field Instrumentation: Rollers, Pressure meters, Piezometer, Pressure cells, Sensors, Inclinometers, Strain gauges etc. Plate load test, pile load test, SPT test, CPT test, flat dilatometer test, DCPT test, Vane shear test, pressure meter test, field CBR test, core cutter, sand replacement test.	

Textbooks

- Alam Singh – Modern Geotechnical Engineering, Asia Publishing House, New Delhi.
- Gopal Ranjan and A.S.R. Rao – Basic and Applied Soil Mechanics, New Age International (P) Ltd.
- B.C. Punamia – Soil Mechanics and Foundations, Laxmi Publications (P) Ltd.
- C. Venkataramaiah – Geotechnical Engineering, New Age International (P) Ltd., New Delhi.

Reference Books

- Schnaid, F. (2009) In Situ Testing in Geomechanics : The Main Tests. Taylor & Francis.
- J. E. Bowles, "Foundation Analysis and Design", McGraw Hill Companies, 1997.
- M. D., Desai, "Ground Property Characterization from In-Situ Testing", Published by IGS-Surat Chapter,2005.
- M. J., Hvorslev, "Sub-Surface Exploration and Sampling of Soils for Civil Engineering Purposes", US Waterways Experiment Station, Vicksburg, 1949.
- Robert M. Koerner "Construction and Geotechnical methods in Foundation Engineering", Mc.Graw-Hill Pub. Co., New York, 1985.
- Manfred R. Haussmann, "Engineering principles of ground modification", Pearson Education Inc. New Delhi, 2008.
- F. G., Bell, "Engineering Treatment of Soils", E& FN Spon, New York, 2006.
- P. Purushothama Raj, "Ground Improvement Techniques" Laxmi Publications (P) Limited, 2006.
- Jie Han et. al., "Advances in ground Improvement" Allied Pub., 2009.
- Hunt Roy E , Geotechnical Investigation Methods, A Field Guide for Geotechnical Engineers, Taylor & Francis Ltd.

ECE- 302		**Advanced Foundation Engineering**
Course category	:	Program Elective-3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, minor tests, and one Major Theory Examination.
Course Objectives	:	The course objectives are given below: 1. To develop basic knowledge about the foundations 2. Ability to choose a suitable foundation on the basis of projects/ ground conditions. 3. Ability to perform the different tests and calculate the loading on foundations. 4. Ability to understand the role of sheeting, bracing and coffer dams in construction.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

		1. To make the students understand the role of the foundation 2. To perform the tests in the field and lab. 3. To have adequate knowledge of I.S. codes on structural safety. 4. To have adequate knowledge to design the piles. 5. To have adequate knowledge of the sheeting and bracing system. 6. To understand the role and design of coffer dams.

Topics Covered	
UNIT-I	9
Introduction to advanced foundation engineering, site investigation & exploration, location, depth of bore holes, and bore log chart	
UNIT-II	9
Shallow foundations, bearing capacity theories, and settlement. I.S. codes on the structural safety of foundations: Allowable total and differential settlements Load tests: Indian Standard specification on load tests, contact pressure distribution	
UNIT-III	9
Pile Foundations: types of pile, allowable load on pile load test, dynamic formula, static formula, pile groups in sands and clays- settlement and bearing capacity, I.S. Codes of piles. behavior of pile under lateral loading- Winkler's assumptions, and theory of beam on elastic foundations. batter pile-methods of analysis.	
UNIT-IV	9
Sheeting and bracing system: earth pressure determination, design method, and design of anchored bulkheads. underpinning of foundations. legal aspects of foundation engineering. Cofferdams: types of cofferdams, design of cellular cofferdams.	

Textbooks

- Design Aid in Soil Mechanics and Foundation Engineering- Kaniraj, pub. McGraw-Hill Publications.

Reference books

- Foundation Design and Construction – Tomilson, pub. Longman Group, UK.
- Foundation Analysis and Design - J. E. Bowles, pub. Tata McGraw-Hill.
- Analysis and Design of Substructures - Swami Saran, pub. Oxford &Ibh Publications.
- 4. Design of Foundation System –Kurian, pub. Alpha Science International.

ECE-502	**Geotechnical Earthquake Engineering**
Course category	Program Elective-5
Pre-requisite subject	NIL
Contact hours/week	Lecture: 3, Tutorial : 1, Practical: 0
No. of credits	4
Course assessment methods	Continuous assessment through attendance, home assignments, quizzes, record, viva voce and One Minor test and One Major Theory Examination
Course Objective	Followings are the course objectives of this course:

	1. Explain earthquake mechanisms, seismic waves, and geotechnical hazards. 2. Differentiate between earthquake magnitude (Richter scale) and intensity (Mercalli scale). 3. Evaluate liquefaction potential using simplified methods. 4. Identify key seismic hazards and site-specific mitigation techniques. 5. Analyse basic seismic design principles for geotechnical structures.
Course outcomes	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: 1. Explain earthquake mechanisms, seismic waves, and geotechnical zards. 2. Differentiate between earthquake magnitude (Richter scale) and intensity (Mercalli scale). 3. Evaluate liquefaction potential using simplified methods. 4. Identify key seismic hazards and site-specific mitigation techniques. 5. Analyse basic seismic design principles for geotechnical structures. 6. Interpret case studies of major earthquakes and their geotechnical impacts.

Topic covered	
Unit 1: Introduction to Earthquakes and Geotechnical Hazards Introduction & Basics of Vibration Theory, Scope of geotechnical earthquake engineering; types of earthquake loading, damped/undamped vibrations, Basics of earthquakes: Plate tectonics, faults, and seismic waves (P, S, surface waves), Geotechnical impacts: Ground shaking, liquefaction, landslides.	9
Unit 2: Earthquake Measurement and Ground Motion Engineering Seismology & Strong Ground Motion, Earthquake causes, plate tectonics, seismic instruments, Magnitude/intensity scales, spectral parameters, attenuation relationships.	9
Unit 3: Soil Dynamics and Liquefaction Wave Propagation & Dynamic Soil Properties, 1D/2D/3D wave equations; seismic, Soil stiffness, damping, liquefaction evaluation (SPT methods), and hazard mapping.	9
Unit 4: Seismic Hazard Analysis and Mitigation Seismic Hazard Analysis, DSHA, PSHA, Site classification and amplification effects. Mitigation strategies: Slope stabilization, foundation design.	9

Text Books:

- Kramer, S.L. Geotechnical Earthquake Engineering (simplified chapters).
- Geotechnical Applications for Earthquake Engineering" by T.G. Sitharam
- Geotechnical Earthquake Engineering Handbook" by Robert W. Day

Reference:

- IS 1893 (Indian Standard for Earthquake-Resistant Design).

ECE-702	**EARTH AND EARTH RETAINING STRUCTURES**
Course category	Program Elective-7
Pre-requisite subject	NIL
Contact hours/week	Lecture: 3, Tutorial : 1 , Practical: 0
No. of credits	4
Course assessment methods	Continuous assessment through attendance, home assignments, quizzes, record, viva voce and One Minor test and One Major Theory Examination
Course Objective	Followings are the course objectives of this course: 1. To understand lateral earth pressure theories and pressure theories and design of retaining walls. 2. To design anchored bulkheads by different methods. 3. To understand pressure envelops and design of various components in braced cuts and cofferdams. 4. To understand stability of earth dams and its protection and construction.
Course outcomes	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: 1. Explain earthquake mechanisms, seismic waves, and geotechnical hazards. 2. Differentiate between earthquake magnitude (Richter scale) and intensity (Mercalli scale). 3. Evaluate liquefaction potential using simplified methods. 4. Identify key seismic hazards and site-specific mitigation techniques. 5. Analyse basic seismic design principles for geotechnical structures. 6. Interpret case studies of major earthquakes and their geotechnical impacts.

Topic covered	
Unit 1: Introduction to geosynthetics, Types of geosynthetics and their applications, Manufacture of geosynthetics, Strength of reinforced soils, testing of geosynthetics, Different types of soil retaining structures, Construction aspects of geosynthetic reinforced soil retaining walls, Design codes for reinforced soil retaining walls.	9
Unit 2: External stability analysis of reinforced soil retaining walls, Seismic loads and internal stability analysis of reinforced soil walls, testing requirements for reinforced soil retaining walls, Design of reinforced soil retaining walls – simple geometry, Design of reinforced soil retaining walls – sloped backfill soil, Design of reinforced soil retaining walls supporting a bridge abutment.	9
Unit 3: Stability analysis of soil slopes – infinite and finite slopes, Stability analysis of reinforced soil slopes resting on soft foundation soils, Stability analysis of reinforced soil slopes	9

resting on strong foundation soil, Stability analysis of reinforced soil slopes – bilinear wedge analysis, Design of embankments supported on load transfer platforms.	
Unit 4: Reinforced soil for supporting shallow foundations, Accelerated consolidation of soft clays using geosynthetics, Geosynthetic encased stone columns for load support, Drainage application of geosynthetics, Filtration applications of geosynthetics, Erosion control using geosynthetics, Natural geosynthetics and their applications, Geosynthetics for construction of municipal and hazardous waste landfills.	9

Books and references:

- Almeida, M. and Marques, M.E.S. (2013) Design and Performance of Embankments on Very Soft Soils, CEC Press, London, U.K.
- Hausmann, M.R. (1976) Engineering principles of ground modification, McGraw-Hill Publishing Co., New York, N.Y. USA.
- Kempfert, H.G. and Gebreselassie, B. (2006) Excavations and Foundations in Soft Soils, Springer, The Netherlands.
- Koerner, R.M. (2012) Designing with Geosynthetics. Vols. 1&2, 6th Edition, Xlibris Corporation, USA.
- Jewell, R.A. (1996) Soil reinforcement with geotextiles, CIRIA & Thomas Telford, London, U.K.
- John, N.W.M. (1987) Geotextiles, Blackie & Son Ltd., London, U.K.
- Jones, C.J.F.P. (2010) Earth Reinforcement and Soil Structures, Thomas Telford, London, U.K.
- Saran, Swami (2006) Reinforced Soil and its Engineering Applications, I.K. International, New Delhi.
- Shukla, S.K. (2012) Handbook of Geosynthetic Engineering, 2nd Edition, ICE Publishing, London, U.K.

ECE-902	**Foundation on Expansive Soil**	
Course category	:	Programme Elective-9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, minor tests, and one Major Theory Examination.
Course Objective		To get exposure on the properties of expansive soils and to study about the substructures placed on expansive soils.
Course Outcomes	:	At the end of the course, students will be able to 1. To assess the occurrence and distribution of expansive soils. 2. To study the properties of expansive soils 3. To study the controlling techniques of expansive soils. 4. To understand various methods of stabilization of expansive soils and foundations used in expansive soils.

		5. Design foundations on expansive soil. 6. Select suitable techniques and understand the mechanism of treatment of swelling Soils.
Topics Covered		
UNIT-I		9
GENERAL PRINCIPLES: Origin of expansive soils, Physical properties of expansive soils, Mineralogical composition, Identification of expansive soils, Field conditions that favour swelling, Consequences of swelling.		
UNIT-II		9
SWELLING CHARACTERISTICS: Swelling characteristics, Laboratory tests, Prediction of swelling characteristics, Evaluation of heave. TECHNIQUES FOR CONTROLLING SWELLING: Horizontal moisture barriers, Vertical moisture barriers, Surface and subsurface drainage, Pre-wetting, Soil replacement, Sand cushion techniques, CNS layer technique.		
UNIT-III		9
FOUNDATIONS ON EXPANSIVE SOILS: Belled piers, Bearing capacity and skin friction, Advantages and disadvantages, Design of belled piers, Under reamed piles, Design and construction.		
UNIT-IV		9
MODIFICATION OF SWELLING CHARACTERISTICS: Lime stabilization, Mechanisms, Limitations, Lime injection, Lime columns, Mixing, Chemical stabilization, Construction.		
Textbooks/ Reference books • FU HUA CHEN, Foundations on Expansive Soils, Elsevier Scientific Publishing Company, New York. • Gopal Ranjan & A.S. Rao, Basic and Applied Soil Mechanics, New Age International Publishers – New Delhi. • Handbook on Underreamed and Bored Compaction Pile Foundation, CBRI, Roorkee. • IS: 2720 (Part XLI) – 1977 – Measurement of Swelling Pressure of Soils. • R.K. Katti, Search for Solutions in Expansive Soils. • Alam Singh, Modern Geotechnical Engineering, Geo-Environ Academia, Jodhapur. • Swami Saran, Analysis and Design of Substructures, Oxford & IBH, New Delhi.		

Minor Degree 3: Environmental Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE -103	Global Warming And Climate Change	3	1	0	4
PE3	ECE -303	Environmental Planning And Management	3	1	0	4
PE5	ECE -503	Environmental Laws And Policy	3	1	0	4
PE7	ECE -703	Environmental Change And Sustainable Development	3	1	0	4
PE9	ECE -903	Environmental Chemistry And Microbiology	3	1	0	4
					Total	20

ECE -103		**Global Warming And Climate Change**
Course category	:	Program Elective- 1
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, Minor tests and One Major Theory Examination.
Course Objectives	:	The main objective is to expand the student knowledge of the climate change, its causes, impacts, and global responses such as the Kyoto Protocol and Clean Development Mechanisms.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course
1. To make the students understand about the sources of energy 2. To understand about the effects of greenhouse gases. 3. To have adequate knowledge on impacts of climate change. 4. To acquire knowledge on modelling on climate change. 5. To have adequate knowledge on carbon credit. 6. To understand rules and protocols on global trading related to global warming.		
Topics Covered		
UNIT-I		9
Energy Sources: Global Warming Potential, Energy Issues and Climate Change, Alternate Energy Sources. Greenhouse Effect: Green house as natural phenomenon, Greenhouse Gases (GHGs) and their Emission, Sources. Quantification of CO2 Emission, Global Warming Potential of GHGs.		

UNIT-II	9
Impacts of Climate Change: Effects on climatic and related changes, Global and Indian, scenario. Temperature Rise. Sea Level rise, Coastal Erosion and landslides, Coastal Flooding. Wetlands and Estuaries loss. Modelling on Climate Change: Case studies on climate change, Data analysis, Interpretation, Ozone layer depletion and its control.	
UNIT-III	9
Kyoto Protocol: Importance. Significance and its role in Climate Change. Carbon Credit and Trading: Mechanisms, Various Models Global and Indian Scenario.	
UNIT-IV	9
Cleaner Development Mechanisms: Various Projects related to CO2 Emission Reduction. Alternatives of Carbon Sequestration - Conventional and non-conventional techniques, Role of Countries and Citizens in Containing Global Warming.	
Textbooks 1. Francis D., (2000), "Global Warming: The Science and Climate Change", 1st Edition, Oxford University Press. **Reference books** 1. Barry R.G., and Chorley R.L., (2017), "Atmosphere, Weather and Climate", 4th Edition, ELBS Publication. 2. Bolin B., (Ed.), (1981), "Carbon Cycle Modelling, John Wiley and Sons Publications. 3. Corell R.W., and Andenon P.A., (Eds). (1991), "Global Environmental Change", Springer Vetlog Publishers.	

ECE -303	**Environmental Planning And Management**	
Course category	:	Programme Elective-3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, Minor tests and One Major Theory Examination.
Course Objective		The main objective is to expand the student knowledge of the principles and practices of environmental sustainability, planning, and protection. The student after learn to integrate environmental, social, and economic dimensions for informed decision-making in sustainable development and resource management.
Course Outcomes	:	The students are expected to be able to demonstrate the following: knowledge, skills and attitudes after completing this course
1. To understand the basic theory of environment and sustainable development. 2. To study the engineering methodology in planning and its limitations. 3. To study the environmental protection 4. To study the Environmental impact assessment and environmental economics. 5. To have adequate knowledge on total quality management in environmental management and protection. 6. To understand about the Environmental audit.		
Topics Covered		

UNIT-I	9
Environment and Sustainable Development - carrying capacity, relationship with quality of life, carrying, indicators of sustainability, sustainability strategies, barriers to sustainability, resource utilization, resource degradation, industrial ecology, socio economic policies for sustainable development and clean development mechanism.	
UNIT-II	9
Engineering Methodology in Planning and Its Limitations - carrying capacity based short and long-term regional planning. Environmental impact assessment (EIA) - definitions and concepts, rationale and historical development of EIA, sustainable development, initial environmental examination, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, measurement of environmental impact, organization, scope and methodologies of EIA, status of EIA in India.	
UNIT-III	9
Environmental Protection - Economic development and social welfare consideration in socio economic developmental policies and planning. Total cost of development and environmental protection cost. Case studies on Regional carrying capacity. Engineering Economics - Value Engineering, Time Value of Money, Cash Flows, Budgeting and Accounting. Environmental Economics: Introduction, economic tools for evaluation, Green GDP, Cleaner development mechanisms and their applications.	
UNIT-IV	9
Environmental Audit - methods, procedure, environmental audit versus accounts audit, compliance audit, methodologies and regulations reporting and case studies, Life cycle assessment; Triple bottom line approach. Total Quality Management in Environmental Management and Protection - ISO 9000, 14000 and 18000 series of standards.	
Textbooks/ Reference books 1. 1. Lohani B.N and North A.M., (1984)., "Environmental Quality Management", South Asian Publishers, New Delhi. 2. Chanlett E.T., (1979), Environmental Protection, McGraw Hill Publication, New York. 3. Danoy G.E., and Warner R.F., (1989), "Planning and Design of Engineering Systems", First Edition, CRC press, Unwin Hyman Publications. 4. MOEF, Government of India, "Carrying Capacity Based Developmental Planning Studies for the National Capital Region", 1995-96. 5. NEERI, Nagpur, Annual Reports 1995 & 1996.	

ECE -503	**Environmental Laws and Policy**	
Course category	:	Programme Elective-5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, Minor tests and One Major Theory Examination.
Course Objective		The main objective is to expand the student knowledge of the comprehensive understanding of environmental laws, policies, and management frameworks in India and globally.
Course Outcomes	:	Students will be able to understand

1. To provide students with a comprehensive understanding of environmental laws, regulatory frameworks, and institutional mechanisms
2. To enable students to critically analyse models of environmental management
3. To develop student competency in environmental auditing, monitoring
4. To able students analyse the sustainability assessment
5. To foster awareness of the roles and responsibilities of government, NGOs, industries.
6. To know about citizens in environmental protection

Topics Covered

UNIT-I	9

Introduction to Environmental Law and Management Models: Evolution and scope of environmental laws in India and globally. Constitutional provisions related to environment (Article 48A, Article 51A (g)). Models of Environmental Management: Command-and-Control, Market-Based Instruments, Voluntary Approaches. The Precautionary Principle, Polluter Pays Principle, Public Trust Doctrine. Environmental Management Tools: EIA (Environmental Impact Assessment), EMS (Environmental Management Systems), Life Cycle Assessment (LCA). Introduction to the Environment Protection Act, 1986

UNIT-II	9

Environmental Policies, Guidelines and Monitoring Mechanisms National Environmental Policy, 2006; Draft National Resource Efficiency Policy. Environmental guidelines and charters (CREP Guidelines, Corporate Environment Responsibility). Environmental auditing and environmental monitoring – types, procedures, and importance. Environmental reporting, economics, and green accounting. Concept of Extended Producer Responsibility (EPR). ESG (Environmental, Social, and Governance) reporting. ISO 14001: Environmental Management System Standards. Role of CPCB, SPCBs, and NGT (National Green Tribunal)

UNIT-III	9

Corporate Strategy, Incentives and Stakeholder Engagement. Theories of corporate strategy and environmental policy: Porter Hypothesis, Triple Bottom Line. Environmental incentives: subsidies, tax incentives, carbon credits, tradable permits. Local Economic Development and Environmental Management. Public-Private Partnership (PPP) in environmental governance. Corporate Social Responsibility (CSR) in environmental management. Case studies on successful industrial environmental practices. Environmental ethics and corporate accountability

UNIT-IV	9

Role of Government, NGOs, and Public Participation. Governmental role in environmental governance – regulatory, facilitative, enabling. Role of Non-Governmental Organizations (NGOs) in environmental awareness and activism. Citizen engagement and participatory governance in environmental policy. Policies beyond environmentalism: Urban development, energy, transportation, and agriculture. Sustainability issues: Climate justice, environmental equity, and intergenerational equity. Climate change policies and India's National Action Plan on Climate Change (NAPCC). Case laws and judicial activism (e.g., Ganga Pollution Case, Vellore Citizens' Welfare Forum Case). Green movements in India (e.g., Chipko, Narmada Bachao Andolan).

Books & References:

1. Divan, S. & Rosencranz, A. – Environmental Law and Policy in India, Oxford University Press
2. Leela krishnan, P. – Environmental Law in India, LexisNexis
3. Cullet, P. – Environmental Law and Policy in India, Routledge
4. UNEP Manuals – Environmental Management and Policies
5. Sahu, G.K. – Environmental Law, Himalaya Publishing House
6. World Bank Reports on environmental governance and local development

7. National Green Tribunal (www.greentribunal.gov.in) – Judgments and Guidelines
8. MOEF&CC – Reports, Notifications, and National Policies
9. International Treaties & Protocols – UNFCC, Kyoto, Paris Agreement (UN websites)
10. Journals – Environmental Policy and Governance, Journal of Environmental Law, Environmental Science & Policy

ECE -703		**Environmental Change and Sustainable Development**
Course category	:	Programme Elective-7
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major
Course Objective		The main objective is to expand the student knowledge of the sustainability, environmental change, and development challenges through global frameworks like the SDGs, systems thinking, and engineering tools.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1 To introduce students to the key concepts, challenges, and debates related to environmental change
2 To develop an understanding of sustainability indicators, systems thinking, and the inter linkages among ecological
3 To understand the students about the SDGs goals.
4 To equip students with engineering tools and frameworks such as life cycle assessment
5 To promote critical thinking on the relevance of traditional knowledge, community-based practices
6 To understand about the traditional approaches to sustainability.

Topics Covered

UNIT-I	9

Foundations of Sustainability and Environmental Change. Introduction to sustainability and sustainable development. Key issues: food security, material consumption, energy resources, and ecological footprint. Ethical dimensions of sustainability: intergenerational equity, environmental justice, planetary boundaries. Global and local resource demands – current trends and future projections. Paradigms of environmental change: from agricultural age to industrial and post-industrial age. Concept of circular economy and resource efficiency. Environmental Kuznets Curve

UNIT-II	9

Population, Growth Limits, and Sustainability Debates. Population growth and resource use: Malthusian theory, Demographic Transition. Limits to Growth (Club of Rome Report) – critical review and current relevance. Carrying capacity and ecological resilience. Current debates in sustainability: green growth vs. degrowth, techno-optimism vs. ecological realism. Environmental movements and grassroots sustainability initiatives. Climate change

and sustainability linkages. Role of education and communication in sustainability transitions.	
UNIT-III	9
Sustainable Development Goals (SDGs) and Systems Thinking. United Nations Sustainable Development Goals (SDGs): Overview and India's progress. Relationships between ecological, economic, and social systems – the "Triple Bottom Line". System dynamics for sustainability assessment. Environmental and social indicators of sustainability (HDI, Ecological Footprint, GPI, etc.). Environmental justice and gender in sustainable development. National missions aligned with SDGs (e.g., National Solar Mission, Swachh Bharat Abhiyan).	
UNIT-IV	9
Engineering and Traditional Approaches to Sustainability. Engineering tools for sustainability: EIA, LCA, carbon footprint analysis, green design. Sustainable engineering practices in energy, water, and construction sectors. Role and relevance of traditional ecological knowledge (TEK) and rural development paradigms. Community-based natural resource management (CBNRM) and participatory approaches. Bioeconomy, green infrastructure, and nature-based solutions. Smart villages and sustainable rural infrastructure in India.	
Textbooks/ Reference books **1.** Kates, R. W., Parris, T. M., & Leiserowitz, A. A. – What is Sustainable Development? Goals, Indicators, Values, and Practice **2.** Meadows, D.H., Meadows, D.L., & Randers, J. – Limits to Growth **3.** Mebratu, D. – Sustainability and Sustainable Development: Historical and Conceptual Review, Environmental Impact Assessment Review **4.** Margerum, R. – Beyond Consensus: Improving Collaborative Planning and Management **5.** MoEF&CC, NITI Aayog, Government of India – Reports on SDGs and sustainability **6.** UNDP – Human Development Reports **7.** World Bank – Reports on climate change and sustainability **8.** CPCB – Guidelines on sustainable development practices in India Chopra, K., and Kadekodi, G.K., Operationalisting Sustainable Development, Sage Publication, New Delhi, 1999. **9.** Roy, K.C., Sen R.K. and Tisdell, C.A., Environment and Sustainable Agricultural Development (Volumes I and II), New Age International Pvt. Ltd., New Delhi, 1996.	

ECE-903		**Environmental Chemistry and Microbiology**
Course category	:	Program Elective- 9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
Number of credits		4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, record, minor tests and One Major Theory Examination.
Course Objectives	:	The purpose behind this course is to make the students familiar with the concepts of chemistry and microbiology involved in the environment.

Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand basic concepts from General Chemistry and Colloidal Chemistry.
2. Understand Environmental Biochemistry and its applications.
3. Perform physico-chemical and biological examination of water and wastewater.
4. Discuss thermodynamics of microbiological systems.
5. Define mass and energy balance of microbial processes.
6. Explain aerobic and anaerobic microbial growth.

Topics Covered

UNIT-I	9
Introduction, basic Concept from General Chemistry, Colloidal Chemistry.	
UNIT-II	9
Environmental Biochemistry, Physico-Chemical and Biological examination of Water and Wastewater.	
UNIT-III	9
Thermodynamic of Microbiological systems	
UNIT-IV	9
Mass and energy Balance of Microbial Process, Aerobic and Anaerobic Microbial growth	

Textbooks/ Reference books

1. Sawyer, C.N, Mc Carty, P.L. and Parkin, G.F, Chemistry for Environmental Engineering and

Science, 5th Edn., Tata & McGraw-Hill Publishing Co. Ltd., New Delhi, 2003.

2. Stummn, and Morgan, J.J, Aquatic Chemistry, John Wiley & sons, New York, 1970.

3. Manahan, S.E, Fundamentals of Environmental Chemistry, Lewis Publishers, Boca Raton,

1993.

Minor Degree 4: Transportation Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE -104	Principles of Highway Engineering	3	1	0	4
PE3	ECE -304	Railway and Airport Engineering	3	1	0	4
PE5	ECE -504	Highway Geometric Design	3	1	0	4
PE7	ECE -704	Intelligent Transportation System	3	1	0	4
PE9	ECE -904	Traffic Engineering	3	0	2	4
					Total	20

ECE -104	**Principle of Highway Engineering**
Course category	Program Elective -1
Pre-requisite subject	NIL
Contact hours/week	Lecture: 3; Tutorial: 1; Practical: 0
No. of credits	4
Course assessment methods	Continuous assessment through tutorials, attendance home assignments, : quizzes, practical work, record, viva voce and one Minor tests and One Major Theory
Course Objective	Followings are the course objectives of this course: 1. To introduce the fundamental principles and scope of highway and transportation engineering 2. To develop skills for planning and conducting highway alignment surveys and preparing related documentation. 3. To familiarize with the various materials used in highway construction 4. To enable application of economic evaluation methods for assessing highway projects and making informed decisions.
Course outcomes	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: 1. Understand the fundamental concepts and scope of highway and transportation engineering. 2. Aware basic road classification and the road authorities in india 3. Plan and carry out highway alignment surveys 4. Identify different types of Materials used in highway construction

	5. Perform and interpret basic laboratory tests on highway materials to assess their suitability for pavement construction. 6. Evaluate highway projects using economic analysis methods
Topic covered	
UNIT-I	9
Highway Introduction, Scope, Planning & Development Highway planning in India, Development, Rural and urban roads, Road departments in India, Road classification, Road authorities i.e. IRC, CRRI, NHAI, NHDP etc	
UNIT-II	9
Highway Alignment & Surveys: Reconnaissance, Aerial surveys, Location surveys, Location of bridges, Problems in rural and urban areas. Highway drawings & reports Highway project preparation	
UNIT-III	9
Highway Materials and construction Aggregates and their types, physical and engineering properties, Fillers, Bitumen, Characteristics, Emulsions and cutbacks, Basic tests on all materials: construction of flexible and rigid pavement.	
UNIT-IV	9
Highway Economics & Finance Financing of road projects, administration of roads, PPP models, Road safety audit, Methods of economic evaluation of highway projects	
Text Books/Reference books: 1. Khanna, S. K. and Justo, C. e. G., Manual for Highway testing manuals, Enchant Bros., Roorkee. 2. Das A and Chakraborty P, Principles of Transportation Engineering, PHI Pvt. Ltd. New Delhi 3. Kadiyali, L.R. & Lal, N.B., Principles & Practices of Highway Engineering, Khanna Publishers, New Delhi. 4. Wright, P. H., Highway Engineering, John Wiley and Sons, New York 5. Indian standards, ASTM Codes, IRC codes, MoRTH Specifications	

ECE -304		**Railway and Airport Engineering**
Course category	**:**	Program Elective-4
Pre-requisite Subject	**:**	NIL
Contact hours/week	**:**	Lecture:3, Tutorial: 1, Practical:0
Number of Credits	**:**	4
Course Assessment methods	**:**	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Minor tests and One Major Theory Examination.
Course Objectives	**:**	1. To explain Components of Railway Track, different Railway Gauges. 2. To design track Gradients as per given requirements. 3. To discuss various Types of Track Turnouts. 4. To describe purposes and facilities at Railway Stations. 5. To explain Interlocking and modern signal system. 6. To describe Surface Defects on Railway Track and Their Remedial Measures.

Course Outcomes	**:**	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course 1. Understand the knowledge of various systems of railway, airport, and water transportation. 2. Understand the components of railway tracks, components, and types of air crafts etc. 3. Understand the design concept of railway track, runway, taxiway. 4. Apply the concept of geometric design of railway, runway, taxiway, docks & harbours etc. 5. Apply the knowledge of various signaling system for railway engineering, air traffic control, navigational aids, etc. 6. Understand the concepts of air traffic control, navigational aids, etc.

Topics Covered

UNIT-I	9

Indian Railways: Development and organization of Indian Railways. Permanent way: Sub-grade formation, embankment and cutting, track damage. Rails: Rail gauges, types of rails, defects in rails, rail failure, creep of rail. Rail Fastenings: Fish plates, spikes, chairs, keys, bearing plates. Sleepers: Timber, steel, cast iron, concrete and prestressed concrete sleepers, manufacturing of concrete sleepers, sleeper density. Ballast: Ballast materials, size of ballast, screening of ballast, specification of ballast, tests on ballast.

UNIT-II	9

Railway Track Geometry: Gradients, horizontal curves, super elevation, safe speed on curves, can't deficiency, negative super elevation, compensation for curvature on gradients, track resistance and tractive power. Points and Crossings: Elements of simple turn-out, details of switch, details of crossings, number and angle of crossings, design of turn-out.

UNIT-III	9

Stations & Yards: Site section for a railway station, layout of different types of stations, classification of stations, types of railway yard, functioning of Marshalling yards. Signaling and Interlocking: Classification of signals, methods of train working, absolute block system, mechanical interlocking of two-line railway stations.

UNIT-IV	9

Airport Engineering: Aircraft characteristics, types of airports, layout of airports, airport planning and design, runway orientation, wind-rose diagram, estimation of runway length and correction. Harbors, Layout and port facilities; inland waterways; inland water operation.

Textbooks

1. A Textbook of Railway Engineering by S. P. Arora & S. C. Saxena.
2. Airport Planning and Design by S. K. Khanna, M. G. Arora

Reference books

1. Railway Engineering - M.M. Aggarwal.
2. Railway Engineering - Vasvani.
3. Railway Engineering - B.L. Gupta and Amit Gupta.

ECE -504		Highway Geometric Design
Course category	:	Program Elective-5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture:3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Minor tests and One Major Theory Examination.
Course Objectives	:	1. To introduce the fundamental factors influencing the planning and geometric design of roadways. 2. To familiarize students with the components of road sections and their design considerations for diverse road users. 3. To develop the ability to design road alignments and infrastructures for future improvements.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course 1. Understand the key design factors to be considered before planning and designing road stretches. 2. Identify and describe the essential elements of a road section based on various types of road users. 3. Design the horizontal and vertical alignment profiles of roadways following standard guidelines. 4. Estimate the traffic handling capacity of roads and determine the need for upgradation. 5. Analyze and design safe and efficient layouts at road infrastructures. 6. Recognize and incorporate associated components essential to a complete road system.

Topics Covered	
UNIT-I	9
Introduction, Design factors, functional classification of roads and Space requirements, Cross-sectional elements – Profiles, Factors controlling, common elements, Specific elements (bicycle and pedestrian facilities, service roads), : Road furniture – Longitudinal markings, Junction markings, Object markings, Messages, Road Traffic Signs, delineators, speed breakers	
UNIT-II	9
Sight distances – Stopping sight distance, Overtaking sight distance, Intermediate sight distance, Head light sight distance; Factors and sight distance under specific conditions	
UNIT-III	9
Highway Alignment – Types, Factors, surveys, Horizontal alignment – guiding principles, simple circular curve, Super elevation, Extra-widening, Transition curve, Gradients, Vertical curves – general guidelines and types; Alignment coordination and issues.	

UNIT-IV	9
Truck Lay byes, Bus Rapid Transport stations and terminals; Toll Plaza layout design, Pedestrian over bridge and subway, Kilometer stone, Clearances and Access control	

Text books/ Reference books

1. Khanna, S. K. and Justo, C. e. G., Manual for Highway testing manuals, Enchant Bros., Roorkee.
2. Kadiyali, L. R., Pr. and design of pavements, Khanna Publishers, New Delhi.
3. Das A and Chakraborty P, Principles of Transportation Engineering, PHI Pvt. Ltd. New Delhi
4. Wright, P. H., Highway Engineering, John Wiley and Sons, New York
5. Indian standards, ASTM Codes, IRC codes, MoRTH Specifications

ECE -704	**Intelligent Transportation System**
Course category	Program Elective-7
Pre-requisite subject	Nil
Contact hours/week	Lecture: 3; Tutorial: 1; Practical: 0
No. of credits	4
Course assessment methods	Continuous assessment through tutorials, attendance home assignments, : quizzes, practical work, record, viva voce and one Minor tests and One Major Theory.
Course Objective	Followings are the course objectives of this course: 1. To introduce the concept, objectives, and evolution of Intelligent Transportation Systems (ITS). 2. To explore the technologies and methodologies used for data collection and communication in ITS. 3. To examine the various functional areas and applications of ITS in modern transportation. 4. To understand user needs and analyze ITS services for effective transportation system management.
Course outcomes	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: 1. Understand the fundamentals and objectives of Intelligent Transportation Systems (ITS) and its evolution. 2. Explain various data collection techniques used in ITS including detectors, AVL, AVI, GIS, and video analytics. 3. Demonstrate the role and functioning of telecommunication systems within ITS infrastructure. 4. Identify and describe the major functional areas of ITS 5. Analyze ITS user needs and service domains such as traffic, transit, payment, safety, and emergency management.

	6. Evaluate the integration of information and communication technologies for efficient traffic and transportation management.

Topic covered	
UNIT-I	9
Introduction to Intelligent Transportation Systems (ITS): Definition of its and Identification of its Objectives, Historical Background, Benefits of ITS, its Collection Techniques - Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information System (GIS), Video Data Collection	
UNIT-II	9
Telecommunication in ITS: Importance of Telecommunications in the its System, Information Management, Traffic Management Centres (TMC), Vehicle - Road Side Communication, Vehicle Positioning System	
UNIT-III	9
ITS Functional Areas: Advanced Traffic Management System (ATMS), Advanced Traveller Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control System (AVCS), Advanced Public Transportation System (APTS), Advance Rural Transportation Systems (ARTS)	
UNIT-IV	9
ITS User Needs and Services: Travel and Traffic Management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle Safety Systems, Information Management	

Reference Books:

1. Sussman, J.M., Perspective on ITS, Artech House Publications, 2005
2. ITS Hand book 2000: Recommendations for world road association (PIARC) by Kan Paul Chen, John Miles
3. Chen, Kan and John C. Miles, ed. ITS Handbook 2000: Recommendations from the World Road Association (PIARC). Artech House Inc, Boston, 1999. 2.
4. McQueen, Bob, Rick Schuman, and Kan Chen. Advanced Traveler Information Systems, Artech House Inc., Boston, 2002.
5. Ozbay, Kaan, and Pushkin Kachroo. Incident Management in Intelligent Transportation Systems, Artech House, Boston.

ECE -904	**Traffic Engineering**
Course category	Program Elective (PE-9)
Pre-requisite Subject	NIL
Contact hours/week	Lecture:3, Tutorial: 0, Practical:2
Number of Credits	4
Course Assessment methods	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and Minor tests and One Major Theory & Practical examination
Course Objectives	1. To introduce the fundamental concepts of traffic engineering 2. To develop an understanding of traffic flow characteristics through analytical and empirical models, and apply these concepts to real-world traffic behavior.

	3. To conduct traffic studies and analyze traffic data 4. To design various traffic infrastructure
Course Outcomes	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course 1. Describe overall element of traffic characteristics and management. 2. Apply traffic stream parameters and models to analyze traffic flow characteristics. 3. Explain different ways to carry out traffic and travel characteristic studies and its analysis. 4. Design of traffic control devices. 5. Use a standard procedure to conduct the traffic survey. 6. Design and analyze traffic infrastructure

Topics Covered

UNIT-I	9
Introduction: Elements of Traffic Engineering, Issues for Traffic Engineers; Road Users, Vehicles, Highways and Control Devices, Modelling Concepts.	
UNIT-II	9
Traffic Stream Characteristics: Traffic Stream Parameters, Time Space Diagram, Relationship Among Q, K, U, Macroscopic Fundamental Diagrams (MFD), Microscopic Models of Traffic Flow, Queuing Theory, Shock Wave Theory.	
UNIT-III	9
Traffic Studies: Traffic Volume Studies, Speed, Travel Time and Delay Studies, Parking Studies, Accident Data Collection and Pedestrian Studies.	
UNIT-IV	9
Traffic Design: Capacity Analysis Concepts- Urban Streets and Rural Highways, Design of Parking Facilities, Street Design, Design of Traffic Signals, Rotaries, Introduction of Grade Separation	

List of experiments

1. Traffic Volume Study
2. Spot Speed Study
3. O&D Study
4. Parking Survey
5. Accident Analysis
6. Road Safety Audit
7. Questionnaire Development, Evaluation and Testing
8. Introduction to Relevant Software

Textbooks/ Reference books

1. Kadiyali, L. R., Traffic Engineering and transport planning, Khanna Publishers, New Delhi.
1. Khistey C.J. and Lall B.K., Transportation Engineering –An introduction, 3rd Edition, PHI Pvt. Ltd, New York (Indian edition also available)
2. William R. Mcshane and Roger P. Roess, ―Traffic Engineering‖, Pearson (4th Edition). 2013
3. C A O'Flaherty, Ed, ―Transport Planning and Traffic Engineering‖, Butterworth Heinemann, Elsevier, Burlington, MA 2006
4. May, A.D., ―Fundamentals of Traffic Flow‖, Prentice Hall, Inc. 2nd Ed. 1990

5. Carlos F. Daganzo. ―Fundamentals of Transportation and Traffic Operations‖, Pergamon 1997
6. Mc Shame W R and Roess R P, Traffic Engineering, Prentice Hall Inc, New Jersey IS and IRC Codes

Minor Degree 5: Water Resources Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE-105	Engineering Hydrology	3	1	0	4
PE3	ECE-305	Soil Water Conservation	3	1	0	4
PE5	ECE-505	Groundwater Hydrology	3	1	0	4
PE7	ECE -705	Water Resources Management	3	1	0	4
PE9	ECE -905	Geoinformatics for Water Resources	3	1	0	4
					Total	20

ECE-105	**ENGINEERING HYDROLOGY**
Course Category	Program Elective (PE-1)
Contact hours/week	Lecture – 3; Tutorial – 1; Practical – 0
Number of credits	4
Course assessment methods	Continuous assessment through attendance, home assignments, quizzes, minor practical exam and One Major Practical Examination
Course Objectives	
1. To study occurrence movement and distribution of water that is a prime resource for development of a civilization. 2. To know diverse methods of collecting the hydrological information, which is essential, to understand surface and ground water hydrology. 3. To know the basic principles of streamflow measurement 4. To understand the principles of watershed management and flood routing	
Course Outcomes	
The students are expected to be able to demonstrate the following knowledge, skills, and abilities after completing this course: 1. A background in the theory of hydrological processes and their measurement 2. Apply science and engineering fundamentals to solve current problems and to anticipate, mitigate and prevent future problems in water resources management 3. An ability to manipulate hydrological data and undertake widely used data analysis. 4. A systematic understanding of the nature of hydrological stores and fluxes and a critical awareness of the methods used to measure, analyse and forecast their variability; and the appropriate contexts for their application. 5. An understanding in principles of watershed management 6. An ability to apply momentum, energy and mass balance equations for routing flood through rivers and reservoirs	
Topics Covered	

Unit – I	9
Introduction: Hydrologic cycle, processes and budget; Fundamentals of hydrometeorology, Indian monsoon system **Frequency Analysis:** Random variables, Probability distribution functions: normal, log-normal, Gumbel, Pearson type-3 uniform distributions; Frequency analysis; Goodness of fit measures.	
Unit – II	9
Precipitation Measurement and Analysis: Precipitation variability, rainfall and snow measurement techniques, design of precipitation gauging network, consistency of rain record, filling up of missing record, estimation of mean areal rainfall, IDF and DAD analysis, Snow measurement and estimation of snow melt. **Hydrologic Abstractions:** Interception and depression storage; Evaporation: factors affecting, measurement and estimation; Evapotranspiration: measurement and estimation; Infiltration, factors affecting infiltration, measurement of infiltration, empirical and analytical models of infiltration; Rain harvesting: procedures and design.	
Unit – III	9
Stream Flow: Runoff process: measurement of stream flow, factors affecting stream flow; Stage-discharge relationship; Peak discharge estimation; hydrograph analysis, base flow separation, unit hydrograph for stream flow estimation, synthetic unit hydrograph, hydrological modeling	
Unit – IV	9
Watershed Management: Watershed and its characteristics; Curve number method; Soil erosion and estimates; Watershed management techniques, Erosion control. **Flood Routing:** Governing equations, Reservoir flood routing, Hydrologic routing: Muskingum method.	
Textbooks	
1. Chow, V.T., Maidment, D.R. and Mays, L.W.: Applied Hydrology, Mc Graw Hill 1998 2. Mays, L.W.: Water resources Engineering, John Wiley and Sons 2001 3. Singh V.P., Elementary Hydrology, Prentice Hall of India 1994 4. Subramanya, K., Engineering Hydrology, 4th Edition, Tata Mc Graw Hill 2013 5. C.W. Fetter, Applied Hydrogeology, Fourth Edition, CBS Publishers and Distributors, New Delhi, 2001 2001 6. H.M. Raghunath, Hydrology: Principles, Analysis and Design, 2nd edition, New Age International Publishers.	

ECE-305	**SOIL WATER CONSERVATION**
Course Category	Program Elective (PE-3)
Contact hours/week	Lecture – 3; Tutorial – 1; Practical – 0
Number of credits	4
Course assessment methods	Continuous assessment through attendance, home assignments, quizzes, minor practical exam and One Major Practical Examination
Course Objectives	
1. To have an understanding about the degradation of productive soil and the causes of its erosion. 2. To make the students understand about the measurement techniques for soil loss and wind erosion. 3. To know the different agronomical and engineering measures adopted for its control along with its design.	
Course Outcomes	

After the completion of the course a student will: 1. Have an understanding of various types of soil, water and wind erosion along with its mitigation measures. 2. Acquire proficiency in application of universal soil loss equation for estimating soil loss/erosion from an area 3. Have a thorough knowledge on causes of water erosion and its control measures 4. Know about the agronomic and engineering methods of conservation and the design of bunds and terraces being implemented on the field. 5. Understand the causes of wind erosion, and methods for controlling wind erosion 6. Be able to provide practical solutions to minimise the erosion loss and conservation of soil.
Topics Covered

Unit – I	9
Soil erosion - Introduction, causes and types; Geological and accelerated erosion; Erosion agents; Factors affecting and effects of erosion. Soil loss estimation – Universal soil loss equation (USLE) and modified USLE; Rainfall erosivity - estimation by KE>25 and EI 30 methods; Soil erodibility and other management factors. Measurement of soil erosion - Runoff plots, soil samplers.	
Unit – II	9
Water erosion - Mechanics and forms; Gullies –Classification & stages of development; Water erosion control measures - agronomical measures - contour farming, strip cropping, conservation tillage and mulching; Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplus arrangements	
Unit – III	9
Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching. Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design	
Unit – IV	9
Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures vegetative, mechanical measures. Design of wind breaks and shelter belts and stabilization of sand dunes; Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks	
Textbooks
1. Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York. 2. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water 3. Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 4. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi. 5. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi. 6. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi

ECE-505	**GROUNDWATER HYDROLOGY**

Course Category	Program Elective (PE-5)
Contact hours/week	Lecture – 3; Tutorial – 1; Practical – 0
Number of credits	4
Course assessment methods	Continuous assessment through attendance, home assignments, quizzes, minor practical exam and One Major Practical Examination

Course Objectives

1. To learn basic fundamentals of groundwater flow
2. To learn the hydraulics of different kinds of wells
3. Conjunctive use of ground water along with other fresh water sources

Course Outcomes

After the completion of the course, a student will be able to:

1. Interpret groundwater field data, identify pollutants, saline water intrusion
2. Acquire preliminary knowledge in identifying the sources of groundwater
3. Apply knowledge of mathematics in deriving groundwater flow equations for steady and unsteady state
4. Comprehend the construction, working and development of wells in confined and unconfined aquifers
5. Understand the causes of groundwater pollution, modelling of contaminants in groundwater system and remedial measures for groundwater pollution
6. Create computer simulation models for groundwater systems

Topics Covered

Unit – I	9

INTRODUCTION: Ground water utilization & historical background, ground water in hydrologic cycle, ground water budget, ground water level fluctuations & environmental influence, literature/ data/ internet resources

OCCURRENCE OF GROUNDWATER: Origin & age of ground water, rock properties affecting groundwater, groundwater column, zones of aeration & saturation, aquifers and their characteristics/classification, groundwater basins & springs,

Unit – II	9

MOVEMENT OF GROUND WATER: Darcy's Law, permeability & its determination, Dupuit assumptions, heterogeneity &anisotropy, Ground water flow rates & flow directions, general flow equations through porous media

ADVANCED WELL HYDRAULICS: steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer, well flow near aquifer boundaries/ for special conditions, partially penetrating/horizontal wells & multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield.

Unit – III	9

POLLUTION AND QUALITY ANALYSIS OF GROUND WATER: Municipal /industrial /agricultural /miscellaneous sources & causes of pollution, attenuation/ underground distribution / potential evaluation of pollution, physical /chemical /biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity & samples, graphical representations of ground water quality.

Unit – IV	9

MODELING AND MANAGEMENT OF GROUND WATER: Ground water modelling through porous media /analog / electric analog / digital computer models, ground water basin management concept, hydrologic equilibrium equation, ground water basin investigations, data collection & field work, dynamic equilibrium in natural aquifers, management potential & safe yield of aquifers, stream-aquifer interaction

Textbooks

1. D.K. Todd and L. F. Mays,"Groundwater Hydrology", John Wiley and sons.
2. K. R.Karanth,"Hydrogeology", TataMcGraw Hill Publishing Company.
3. S. Ramakrishnan,"Ground water",S. Ramakrishnan.

ECE-705	**WATER RESOURCES MANAGEMENT**
Course Category	Program Elective -7
Contact hours/week	Lecture – 3; Tutorial – 1; Practical – 0
Number of credits	4
Course assessment methods	Continuous assessment through tutorials, attendance home assignments, quizzes, and one Minor tests, and One Major Theory examination
Course Objectives	
1. Acquire the basic principles of water resources and its planning and management. 2. Enhance the knowledge on recent technologies in assessing the water resources. 3. Identify the challenges facing water management in varied climate types around the world.	
Course Outcomes	
After the completion of the course, a student will: 1. Understand the planning of water resources and need for water resource management. 2. Understand the water resource potential in global, India scenario and explore the water resources using different technologies. 3. Acquire a knowledge international and national water law and its policy. 4. Explain the concept of water in agricultural and economic aspects. 5. Predict the future trends of water demand and its management during crisis 6. Be aware of various national and international laws associated with water usage	
Topics Covered	
Unit – I	9
Water, A Multi-Dimensional Resource: Water resources planning- multi-dimensional management-Water withdrawal and consumption by sector-Stress, international policy-Climate change, oceans, challenges and need for water resource management **Global and Indian Scenario for Water Resources:** Surface Water and Groundwater Global and Indian Scenario-Quality of water resources Water use and sustainable reuse methods-Usable water resources by continent and country-Water footprint.	
Unit – II	9
Water Resources Assessment: Network design-Stream flow gauging-Weir design-Gauges-Current gauging-Salt dilution Geophysical Exploration-Test drilling-Application of remote sensing techniques **Water in Agricultural Systems:** Water for food production, virtual water trade for achieving global water security, irrigation efficiencies, irrigation methods and current water pricing, water for livestock and processing, water pollution from agricultural production	
Unit – III	9
Water Economics: Economic characteristics of water good and services-Nonmarket monetary valuation methods-Water economic instruments-Policy options for water conservation and sustainable use, pricing, distinction between values and charges-Private sector involvement in water resources management.	
Unit – IV	9

Water Legal and Regulatory Settings: National and International Framework for Water Law; Basic structure of water law- An overview of water law in India -Evolution of water law, key features of water law, evolving water law and policy-Water policy for Irrigation, decentralization and participation in irrigation management, and the policy measures proposed to establish water user associations. National level initiatives for regulation of groundwater, State groundwater laws and rainwater harvesting.
Textbooks
1. David Stephenson, Water Resources Management, 2004, A. A. Balkema Publishers, Netherlands. 2. Louis Theodore, Ryan Dupont R., Water Resource Management Issues, Basic Principles and Applications, 2020, CRC Press, Taylor & Francis Group, New York. 3. Philippe Cullet and Sujith Koonan, Water Law in India- An Introduction to Legal Instruments, 2017. Second Edition, Oxford University Press, New Delhi. 4. Subramanya. K., Engineering Hydrology, 2020, Fifth Edition, McGraw Hill Education Pvt. Ltd., New Delhi.

ECE-905	**GEOINFORMATICS FOR WATER RESOURCES**
Course Category	Program Elective-9
Contact hours/week	Lecture – 3; Tutorial – 1; Practical – 0
Number of credits	4
Course assessment methods	Continuous assessment through tutorials, attendance home assignments, quizzes, and one Minor tests, and One Major Theory examination
Course Objectives	
Enhance the capability and advanced knowledge of Geoinformatics tools and technique to understand, monitor, mapping and management of Water Resources in various aspects.	
Course Outcomes	
1. Develop appropriate methods for studying and/or solving the problems related to hydrological cycle, estimation of hydrological parameter and water budget with the help of RS&GIS 2. Acquire know-how in watershed mapping, classification, and prioritization 3. Able to provide geo-information science and earth observation technology to watershed management and prioritization 4. Hands on training on geoinformatics tools and technique in the application of water resources 5. Knowledge of snow/glacier mapping and sedimentation analysis due to snow melt 6. Application of GIS and remote sensing for oceanographic studies	
Topics Covered	
Unit – I	9
Overview of RS & GIS Application in Water Resources Management: Hydrological Modelling with Geospatial Inputs; Hydrological cycle, Estimation of precipitation, Hydrological Parameter Estimation using RS & GIS; Digital Elevation Model (DEM) hydro processing; Drainage network and drainage pattern, watershed definition and scope, morphometric parameter	
Unit – II	9
Watershed Characterization: Watershed Prioritization and Conservation Planning; Aquatic System; Classification of Wetland and Wetland mapping using Remote Sensing; Water balance studies- interception, soil moisture, evaporation, run off and discharge	
Unit – III	9

Snow/Glacier Mapping: Monitoring and Snow Melt Runoff Model; Soil erosion and Sediment modelling, Reservoir Sedimentation Assessment using Remote Sensing	
Unit – IV	9
Application of remote sensing in Oceanography: Sea Surface Temperature, Chlorophy-ll, Total Suspended Solids, Fishing potential and Coastal wetland. Monitoring of Hydro-meteorological Disasters and Damage Assessment; Flood Modelling and Early Warning Systems,	
Textbooks	
1. Jensen J. R, Remote Sensing of the Environment: An Earth Resource Perspective, Pearsons, 2009. 2. Lillesand T, Kiefer RW and Chipman J, Remote Sensing and Image Interpretation, Wiley &Sons. 2009. 2. Chang K., Introduction to Geographic Information Systems, McGraw-Hill, New York, 2006. 3. JVS Murty, 2004, "Watershed management" New Age International Pvt Ltd, New Delhi 4. Lyon JG GIS for Water Resources and Watershed Management Chen Y, GIS and Remote Sensing in Hydrology, Water Resources and Environment, 2004 5. W.G.M. 1998. Remote sensing in water resources management: the state of the art. Colombo, Sri Lanka: IWMI	

Minor Degree 6: Geospatial Technology

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECE-106	Global Positioning System	3	1	0	4
PE3	ECE-306	Principle of Remote Sensing	3	1	0	4
PE5	ECS-506	Web Technology for GIS & Mapping	3	0	2	4
PE7	ECS-706	Spatial Information Technology	3	1	0	4
PE9	ECS-906	Spatial Data Quality Assessment	3	1	0	4
					Total	20

ECE-106	**Geographic Information System**	
Course category	:	PE-1
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture:3,Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance home assignments, quizzes, and one Minor tests, and One Major Theory examination
Course Objectives	:	This course aspires to: Introduce basic concepts in GIS, provide exposure to basic tools and techniques in GIS software and Introduce applications of GIS in relevant areas of civil engineering.
CourseOutcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course 1. Define what GIS is and know different types of spatial and non spatial data 2. Understand the GIS and its Data models 3. Know what are the questions that GIS can answer 4. Differentiate between Raster and Vector Models 5. Create maps and overlay features/raster data for basic analyses 6. Understand the applications of GIS in the fields of environmental, geotechnical, transportation and water resources engineering

Topics Covered	
UNIT-I	9
Definition of GIS, Cartography and GIS, GIS database: spatial and attribute data; Spatial models: Semantics, spatial information, temporal information, conceptual models of spatial information, Computer representation of geographic information: Regular tessellations, irregular tessellations, Vector representations, Topology and Spatial relationships, Scale and Resolution, Representation of Geographic fields, Representation of Geographic objects	
UNIT-II	9

Raster and vector data input, raster to vector data conversion, map projection, analytical transformation, rubber sheet transformation, manual digitizing and semi-automatic line following digitizer; Remote sensing data as an input to GIS data

Direct and indirect spatial data capture Accuracy and Precision, Positional accuracy, Attribute accuracy, temporal accuracy, Lineage, Completeness, Logical consistency

UNIT-III	9

GIS database Concepts and management systems, Types of Database management Systems, hierarchical, network, relational models, Object oriented DBMS, GIS functionality; data storage and data retrieval through query, generalization, classification, containment search within a spatial region

UNIT-IV	9

Overlay: arithmetical, logical and conditional overlay, buffers, inter visibility, aggregation; Network analysis; Applications of GIS in planning and management of utility lines and in the field of environmental engineering, geotechnical engineering, transportation engineering and water resources engineering

Textbooks

1. Stan Arnoff Geographic Information Systems: A Management Perspective, WDL Publications.
2. C.P. Lo and Albert K. W. Yeung, Concepts and Techniques of Geographical Information Systems, Prentice- Hall India
3. Reddy, M. Anji, Remote sensing and Geographic Information System BS Publications Hyderabad
4. B. Bhatta, Remote Sensing and GIS, Oxford University Press

Reference books

1. Robert Laurini and Derek Thompson Fundamentals of Spatial Information Systems, Academic Press.
2. Tor Bernhardsen Geographic Information Systems: An Introduction, Wiley
3. Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication
4. Michael N. DeMers, Fundamentals of Geographic Information Systems, Wiley

ECE-306	PRINCIPLES OF REMOTE SENSING	
Course category	:	PE 3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture:3,Tutorial:1,Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance home assignments, quizzes, and one Minor tests, and One Major Theory examination
Course Objectives	:	To learn the principles of remote sensing phenomenon including image acquisition, analysis and processing to extract information
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course
		1. Understand the way in which electromagnetic radiation interacts with the earth's atmosphere, the earth's surface and the remote sensing system. 2. Be familiar with different types of sensors and remote sensing space missions that are used to detect and record certain parts of the electromagnetic spectrum. 3. Understand simple image enhancement, filtering operations over digital images 4. To carry out corrections of geometric distortions in digital images 5. Develop a knowledge and understanding of spectral classification of images for feature extraction 6. Understand the principles of GPS and its role in Remote sensing ground truthing

Topics Covered

UNIT-I	9
Remote sensing system and its components, Electromagnetic spectrum, definition of emissivity, reflectance, absorbance and transmittance. Spectral signature, atmospheric window, active and passive remote sensing systems, Interaction of electromagnetic energy with atmosphere and earth features, factors affecting the reflectance, Thermal and Microwave Remote Sensing.	
UNIT-II	9
Airborne and space platforms, Advantages and disadvantages of each, principle and functioning of multi-spectral, thermal & line scanners, Multi concept of remote sensing, Different satellite and sensor combinations: LANDSAT, SPOT, IRS series of satellites and sensors. Their important characteristics: such as flight altitude, IFOV, spatial resolution, swath, spectral bands, and repetivity.	
UNIT-III	9
Introduction to Digital Image Processing, digital image representation, and characterization, Concept of colour, Colour composites, histograms and scatter plot, image enhancement, contrast stretching, radiometric processing including correction of atmospheric corrections; geometric corrections, Image Transformations such as subtraction, ratioing, NDVI and PCA	
UNIT-IV	9
Ground truth: Geographic and Radiometric, Thematic classification and clustering to include unsupervised and supervised classification based on parallelepiped, minimum distance and maximum likelihood classification, accuracy assessment of classification. Applications of remote sensing, Image transformations	

Textbooks

1. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman., Remote Sensing and Image Interpretation. Wiley
2. Reddy, M. Anji, Remote sensing and Geographic Information System BS Publications
3. B. Bhatta, Remote Sensing and GIS, Oxford University Press

Reference books

1. Curran, Paul J., Principles of Remote sensing Longman
2. Campbell, J.B., Introduction of Remote Sensing Taylor and Francis
3. Sabins, F.F., Remote Sensing: Principles and Interpretations Waveland Pr Inc Publishers