UNIVERSITY DEPARTMENTS - R2019

FACULTY OF CIVIL ENGINEERING

B.E. / B. TECH. (HONS)

B.E. CIVIL ENGINEERING

PROFESSIONAL ELECTIVE COURSES (PEC): VERTICALS

VERTICAL I (Structures)	VERTICAL II Construction Techniques and Practices)	VERTICAL III (Geotechnical)	VERTICAL IV (Geo-Informatics)	VERTICAL V (Transportation Infrastructure)	VERTICAL VI (Environment)	VERTICAL VII (Water Resources)	VERTICAL VIII (Ocean Engineering)
Concrete Technology	Construction Equipment and Machinery	Geo-Environmental Engineering	Environmental Geoinformatics	Traffic Engineering and Management	Climate Change Adaptation and Mitigation	Hydrology and Water Resources Engineering	Oceanography
Prefabricated Structures	Construction Project Management through Lean Concepts	Ground Improvement Techniques	Transportation Geomatics	Transportation Planning Process	Air Pollution Control Engineering	Integrated Water Resources Management	Ocean Wave Dynamics
Prestressed Concrete Structures	Construction Quality and Safety	Soil Dynamics and Machine Foundations	Geomatics for Hydrology and Water Resources	Urban and Regional Planning	Environmental Impact Assessment	Groundwater Engineering	Sea Surveying and Monitoring
Structural Retrofit and Rehabilitation	Advanced Construction Techniques	Rock Mechanics	Geomatics for Disaster and Risk Mitigation	Transport and Environment	Industrial Wastewater Management	Watershed Management	Port and Harbour Engineering
Dynamics and Earthquake Resistant Structures	Energy Efficient Buildings	Earth and Earth Retaining Structures	Geomatics for Agriculture and Forestry	Smart Cities	Solid and Hazardous Waste Management	Rainwater Harvesting	Coastal Engineering
Introduction to Finite Element Method	Digitalized Construction Lab	Pile Foundations	Geomatics for Ocean and Coastal Applications	Intelligent Transportation Systems	Environmental Legislations in India	Water Resources and Global Climate Change	Offshore Technology

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered from Semesters V to VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, more than one course is permitted from the same row, provided each course is enrolled in different semester

The registration of courses for B.E./B.Tech (Hons) shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Hons) also. For more details on B.E./B.Tech (Hons) refer to the Regulations 2019, Clause 4.11.

UNIVERSITY DEPARTMENTS - R2019

FACULTY OF CIVIL ENGINEERING

B.E. / B. TECH. (HONS)

B.E. CIVIL ENGINEERING

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL I: STRUCTURES

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	CE5031	Concrete Technology	3	0	0	3	3
2.	CE5020	Prefabricated Structures	3	0	0	3	3
3.	CE5032	Prestressed Concrete Structures	3	0	0	3	3
4.	CE5033	Structural Retrofit and Rehabilitation	3	0	0	3	3
5.	CE5034	Dynamics and Earthquake Resistant Structures	3	0	0	3	3
6.	CE5035	Introduction to Finite Element Method	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL II: CONSTRUCTION TECHNIQUES AND PRACTICES

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	CE5036	Construction Equipment and Machinery	3	0	0	3	3
2.	CE5037	Construction Project Management Through Lean Concepts	3	0	0	3	3
3.	CE5038	Construction Quality and Safety	3	0	0	3	3
4.	CE5039	Advanced Construction Techniques	3	0	0	3	3
5.	CE5040	Energy Efficient Buildings	3	0	0	3	3
6.	CE5041	Digitalized Construction Lab	0	0	6	6	3

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL III: GEOTECHNICAL

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	CE5023	Geo-Environmental Engineering	3	0	0	3	3
2.	CE5024	Ground Improvement Techniques	3	0	0	3	3
3.	CE5025	Soil Dynamics and Machine Foundations	3	0	0	3	3
4.	CE5026	Rock Mechanics	3	0	0	3	3
5.	CE5042	Earth and Earth Retaining Structures	3	0	0	3	3
6.	CE5043	Pile Foundations	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL IV: GEO-INFORMATICS

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	GI5006	Environmental Geoinformatics	3	0	0	3	3
2.	GI5005	Transportation Geomatics	3	0	0	3	3
3.	GI5016	Geomatics for Hydrology and Water Resources	3	0	0	3	3
4.	GI5017	Geomatics for Disaster and Risk Mitigation	3	0	0	3	3
5.	GI5071	Geomatics for Agriculture and Forestry	3	0	0	3	3
6.	GI5018	Geomatics for Ocean and Coastal Applications	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL V: TRANSPORTATION INFRASTRUCTURE

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	CE5011	Traffic Engineering and Management	3	0	0	3	3
2.	CE5044	Transportation Planning Process	3	0	0	3	3
3.	CE5045	Urban and Regional Planning	3	0	0	3	3
4.	CE5012	Transport and Environment	3	0	0	3	3
5.	CE5046	Smart Cities	3	0	0	3	3
6.	CE5047	Intelligent Transportation Systems	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL VI: ENVIRONMENT

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	CE5048	Climate Change Adaptation and Mitigation	3	0	0	3	3
2.	CE5049	Air Pollution Control Engineering	3	0	0	3	3
3.	CE5050	Environmental Impact Assessment	3	0	0	3	3
4.	CE5051	Industrial Wastewater Management	3	0	0	3	3
5.	CE5052	Solid and Hazardous Waste Management	3	0	0	3	3
6.	CE5053	Environmental Legislations in India	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL VII: WATER RESOURCES

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	CE5071	Hydrology and Water Resources Engineering	3	0	0	3	3
2.	CE5072	Integrated Water Resources Management	3	0	0	3	3
3.	CE5008	Groundwater Engineering	3	0	0	3	3
4.	CE5054	Watershed Management	3	0	0	3	3
5.	CE5055	Rainwater Harvesting	3	0	0	3	3
6.	CE5056	Water Resources and Global Climate Change	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)
VERTICAL VIII: OCEAN ENGINEERING

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	CE5057	Oceanography	3	0	0	3	3
2.	CE5058	Ocean Wave Dynamics	3	0	0	3	3
3.	CE5059	Sea Surveying and Monitoring	3	0	0	3	3
4.	CE5060	Port and Harbour Engineering	3	0	0	3	3
5.	CE5061	Coastal Engineering	3	0	0	3	3
6.	CE5062	Offshore Technology	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)

VERTICAL I: STRUCTURES

CE5031 CONCRETE TECHNOLOGY L T P C
3 0 0 3

UNIT I FRESH AND MECHANICAL PROPERTIES 9

Fresh concrete: Workability - Concepts and tests as per Indian codal specifications - Concrete manufacturing stages: Batching - Mixing - Transportation - Placing of concrete - Curing of concrete - Water: Quality of water for mixing and curing - Hardened concrete: Factors affecting strength of concrete - Compressive strength test - Split tensile strength - Flexure test - Modulus of elasticity.

UNIT II ADMIXTURES 9

Admixtures - Types - Natural admixtures - Fly ash - Slag - Metakaolin - Rice husk ash - Micro and nano silica - Mineral additives and fillers - Chemical admixtures: Accelerators - Retarders - Plasticizers and Super plasticizers - Air entraining admixtures - Water proofers - Coloring agent.

UNIT III MIX DESIGN 9

Mix Design - Factors influencing mix proportion - Design mix and nominal mix - Mix design by IS method using IS 10262-2019 - Variability in test results - Quality control - Sampling and acceptance criteria.

UNIT IV SPECIAL CONCRETES AND CONCRETING METHODS 9

Special concretes: Light weight concrete - Fibre reinforced concrete - Polymer concrete - Ferrocement - Ready mix concrete - Self compacting concrete - Geopolymer concrete - High performance concrete. Concrete methods: Extreme weather concreting - Vacuum concrete - Underwater concreting.

UNIT V NON-DESTRUCTIVE TEST AND DURABILITY OF CONCRETE 9

Non-destructive tests: Rebound hammer - Ultra sonic pulse velocity test - Core test - Durability of concrete - Permeability of concrete - Creep and Shrinkage - Plastic shrinkage - Drying shrinkage - Chemical attack - Sulfate attack - Chloride attack - Mechanism of corrosion - Remedial measures - Application of IoT in smart curing system for concrete.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Have thorough knowledge of the fresh and mechanical properties of concrete
CO2 Explain the effect of admixtures on the behaviour of concrete
CO3 Design concrete mix design by IS method and be aware of the acceptance criteria as per code
CO4 Explore the application of special concretes for practical purposes and special concreting methods
CO5 Describe and carry out non-destructive and durability tests on concrete

TEXTBOOKS:

1. Shetty M. S., “Concrete Technology”, Theory & Practice, S. Chand and Co., 2019.
2. Bhavikatti S. S., “Concrete Technology”, I. K. International Publishing House Pvt. Limited, 2015.
3. Gupta.B. L. and Amit Gupta, “Concrete Technology”, Jain Book Agency, 2010.

REFERENCES:

1. Kumar Mehta P., Paulo and Moteiro J. M., “Concrete-Micro Structure, Properties and Materials”, 3rd Edition, Mcgraw Hill, 2006.
2. Santhakumar A. R., “Concrete Technology”, Oxford University Press, New Delhi, 2018.
3. Job Thomas, “Concrete Technology”, Cengage learning India Pvt. Ltd., 2015.

4. Gambhir M. L., “Concrete Technology”, Tata McGraw Hill, 2012.
5. Nevile A. M., “Properties of Concrete”, Longman Publishers, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	3	3	2	2	2	2	2	1	2	3	2	2
2	2	2	2	2	2	3	3	2	1	2	1	3	3	2	2
3	3	3	3	3	2	2	1	1	1	2	2	2	2	2	2
4	3	3	2	2	3	2	2	2	2	2	2	3	3	3	3
5	3	3	3	3	3	3	3	2	2	2	2	2	3	2	3
Avg.	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5020 PREFABRICATED STRUCTURES L T P C
3 0 0 3

UNIT I INTRODUCTION 10
Need for prefabrication - Principles - Materials - Modular co-ordination - Standardization - Systems Production - Transportation - Erection - Disuniting of structures.

UNIT II PREFABRICATED COMPONENTS 10
Behavior of structural components - Large panel constructions - Construction of roof, floor slabs and wall panels - Columns - Shear walls.

UNIT III DESIGN PRINCIPLES 10
Design of structural components - Beam, column and corbel - Stress limitations - Handling without cracking, handling with controlled cracking - Design for stripping forces.

UNIT IV JOINTS IN STRUCTURAL MEMBERS 8
Joints for different structural connections - Beam-to-column, beam-to-beam, column-to-column, column-to-foundation - Connections between wall panels - Connections between floor panels - Dimensions and detailing - Design of expansion joints - Jointing materials.

UNIT V DESIGN FOR EARTHQUAKES AND CYCLONES 7
Progressive collapse - Codal provisions - Equivalent design loads for considering abnormal effects such as earthquakes, cyclones etc. - Importance of avoidance of progressive collapse.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student is expected to be able to:
CO1 Understand the principles of modular coordination
CO2 Know the construction of roof and floors
CO3 Design for stripping forces
CO4 Identify the different types of connections between structural members
CO5 Understand the concept of progressive collapse

TEXTBOOKS:

1. Hubert Bachmann and Alfred Steinle, “Precast Concrete Structures”, 2012.
2. Laszlo Mokk, “Prefabricated Concrete for Industrial and Public Structures”, Akademiai Kiado, Budapest, 1964.

REFERENCES:

1. “PCI Design Hand Book”, 6th Edition, 2004.
2. “Handbook on Precast Concrete for Buildings”, ICI Bulletin 02, First Edition, 2016.
3. A. S. G. Bruggeling and G. F. Huyghe, “Prefabrication with concrete”, Netherlands: A. A. Balkema Publishers, 1991.
4. Glover C. W., “Structural Precast Concrete”, Asia Publishing House, 1965.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	2	2	2	3	1	1	1	2	3	2	3
2	3	2	2	2	2	2	2	3	1	1	1	2	3	2	3
3	3	3	3	2	2	2	2	3	1	1	1	2	3	2	3
4	3	3	3	2	2	2	2	3	1	1	1	2	3	2	3
5	3	3	3	2	3	2	2	3	1	1	1	2	3	2	3
Avg.	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**2**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5032 PRESTRESSED CONCRETE STRUCTURES L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Historical developments - Advantages over ordinary reinforced concrete - Basic principles of prestressing - Classification and types - Materials - High strength concrete and high tensile steel - Methods of prestressing - Freyssinet, Magnel, Lee-McCall and Gifford Udall anchorage systems - Stress distribution: stress concept, strength concept and load balancing concept - Losses of prestress in post-tensioned and pre-tensioned members.

UNIT II DESIGN FOR FLEXURE AND SHEAR 9

Design of post-tensioned and pre-tensioned beam sections - Influence of layout of cables in post-tensioned beams - Design for shear based on I.S. 1343 code.

UNIT III DEFLECTION AND DESIGN OF ANCHORAGE ZONE 9

Factors influencing deflections - Short-term deflections of uncracked members - Prediction of long-term deflections due to creep and shrinkage - Check for serviceability limit state of deflection - Transmission of prestress - Determination of anchorage zone stresses in post-tensioned beams - Design of anchorage zone reinforcement - Check for transfer bond length in pre-tensioned beams - Design of end zone reinforcement.

UNIT IV COMPOSITE BEAMS AND CONTINUOUS BEAMS 9

Analysis and design of composite beams - Shrinkage strain and its importance - Methods of achieving continuity in continuous beams - Analysis for secondary moments - Concordant cable and linear transformation - Calculation of stresses - Principles of design.

UNIT V MISCELLANEOUS STRUCTURES 9

Prestressed concrete tension members - Pipes, cylindrical water tanks - Prestressed concrete compression members - Piles.

TOTAL: 45 PERIODS

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

CO1 Design a prestressed concrete beam accounting for losses
CO2 Design for flexure and shear
CO3 Design the anchorage zone for post tensioned members and deflection in beams
CO4 Design composite members and continuous beams
CO5 Design pipes, water tanks and piles

TEXTBOOKS:
1. Krishna Raju N., "Prestressed Concrete", Tata McGraw Hill Company, Fifth edition, 2012.
2. Pandit G. S. and Gupta S. P., "Prestressed Concrete", CBS Publishers and Distributers Pvt. Ltd., Second edition, 2014.

REFERENCES:
1. Lin T. Y. and Ned H. Burns, "Design of Prestressed Concrete Structures", John Wiley and Sons, Third Edition, 1981.
2. Rajagopalan N., "Prestressed Concrete", Narosa Publishing House, 2002.
3. Dayaratnam P. and Sarah P., "Prestressed Concrete Structures", Seventh Edition, Oxford and IBH, 2017.
4. Sinha N. C. and Roy S. K., "Fundamentals of Prestressed Concrete", S. Chand and Co. Ltd., 2011.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	2	2	2	3	1	1	1	2	3	3	3
2	3	2	3	2	2	2	2	3	1	1	1	2	3	3	3
3	3	3	3	2	3	2	2	3	1	1	1	2	3	3	3
4	3	3	3	3	3	2	2	3	1	1	1	2	3	3	3
5	3	3	3	3	3	2	2	3	1	1	1	2	3	3	3
Avg.	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5033 STRUCTURAL RETROFIT AND REHABILITATION L T P C
3 0 0 3

UNIT I MAINTENANCE AND REPAIR STRATIGES 9
Maintenance, repair and rehabilitation - Facets of maintenance - Importance of maintenance - Various aspects of inspection - Service life behavior - Assessment procedure for evaluating a damaged structure - Causes of deterioration.

UNIT II STRENGTH AND DURABILITY OF CONCRETE 9
Quality assurance for concrete - Strength and durability of concrete - Cracks, different types, causes - Effects due to climate, sustained elevated temperature, corrosion - Methods to assess the quality of hardened concrete.

UNIT III SPECIAL CONCRETES 9
Polymer concrete - Sulphur infiltrated concrete - Fibre reinforced concrete - High strength concrete - High performance concrete - Vacuum concrete - Self compacting concrete - Geopolymer concrete - Reactive powder concrete - Concrete made with industrial wastes.

UNIT IV TECHNIQUES FOR REPAIR AND PROTECTION METHODS 9

Epoxy injection - Shoring - Underpinning - Corrosion protection techniques - Corrosion inhibitors, corrosion resistant steels, coatings to reinforcement, cathodic protection.

UNIT V REPAIR, REHABILITATION AND RETROFITTING OF STRUCTURES 9

Strengthening of structural elements - Repair of structures distressed due to corrosion, fire, leakage and earthquake - Demolition techniques - Engineered demolition methods - Case studies - Restoration of heritage structures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Know the importance of inspection and maintenance
CO2 Study the impacts of cracks, corrosion and climate on structures
CO3 Know about high performance concrete
CO4 Understand the materials and techniques needed for repairs
CO5 Know the failures of the structures and demolition techniques

TEXT BOOKS:

1. Shetty M. S. and Jain A. K., "Concrete Technology - Theory and Practice", S. Chand and Company, Eighth Edition, 2019.
2. B. Vidivelli, "Rehabilitation of Concrete Structures", Standard Publishes Distribution, 1st Edition, 2009.

REFERENCES:

1. "Handbook on Seismic Retrofit of Buildings", CPWD and Indian Buildings Congress, Narosa Publishers, 2008.
2. Hand Book on "Repair and Rehabilitation of RCC Buildings", Director General works, CPWD, Govt. of India, New Delhi, 2002.
3. P. C. Varghese, "Maintenance, Repair and Rehabilitation & Minor works of building", Prentice Hall India Pvt. Ltd., 2014.
4. R. Dodge Woodson, "Concrete Structures, Protection, Repair and Rehabilitation", Butterworth-Heinemann, Elsevier, New Delhi, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	-	3	-	-	-	-	2	-	1	-	2	-	-
2	2	2	-	3	-	-	3	2	2	1	-	-	2	-	-
3	-	-	3	-	3	2	-	2	-	-	-	2	-	3	2
4	-	-	2	-	3	3	3	2	-	-	-	2	-	3	3
5	2	-	3	-	2	2	2	-	-	-	-	2	-	2	2
Avg.	**2**	**2**	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**3**	**2**

• 1' = Low; '2' = Medium; '3' = High

CE5034 DYNAMICS AND EARTHQUAKE RESISTANT STRUCTURES L T P C
3 0 0 3

UNIT I INTRODUCTION TO DYNAMICS 9

Dynamics - Degree of freedom - Free and forced vibration - Idealization of structure as single degree of freedom (SDOF) and multi degree of freedom (MDOF) system - D' Alembert's principles - Formulation of equation of motion for SDOF system and MDOF system - Evaluation of natural

frequencies and modes - Orthogonality principle - Modal superposition method - Response to forced vibrations - Effect of damping.

UNIT II SEISMOLOGY 9

Earthquake phenomenon - Seismo-tectonics - Elastic rebound theory - Seismic waves - Intensity and magnitude - Seismic instrumentation - Strong earthquake motion - Estimation of earthquake parameters - History of earthquakes in India - Seismic zonation of India - Micro-zonation - Liquefaction of soil - Soil-structure interaction - Tsunami - Seismic hazard analysis - Response spectra.

UNIT III EARTHQUAKE EFFECTS ON STRUCTURES 9

Inertia force on structures - Load transfer path - Effect of architectural features on behavior of structures - Hysteretic behaviour of R.C.C., steel and prestressed concrete - Pinching effect - Bauschinger effects - Energy dissipation - P-delta effect - Story drift - Behavior of brick masonry, stone masonry and reinforced concrete structures under past earthquakes - Typical failures - Causes of damage - Lessons learnt from past earthquakes.

UNIT IV ANALYSIS OF STRUCTURES FOR EARTHQUAKE LOAD 9

Design spectra - Codal provision - Evaluation of earthquake forces - Different methods of analysis for earthquake loads - Analysis of structure by equivalent static method - Analysis of structure by response spectrum method - Introduction to time-history method of analysis.

UNIT V EARTHQUAKE RESISTANT DESIGN 9

Philosophy of earthquake resistant design - Planning considerations and architectural concepts - Design and detailing as per codal provisions - Design and detailing of typical flexural member and column member - Ductile detailing of beam-column joints and footing - Concept and principle of shear wall - Structural systems for lateral load resistance in building - Seismic isolation principles and methods - Introduction to performance based seismic design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Develop the equations of motion for SDOF and MDOF system and to evaluate the natural frequencies and mode shapes

CO2 Explain the elements of engineering seismology, characteristics of earthquake and seismic instrumentation

CO3 Explain the behavior of various types of structures under earthquake

CO4 Estimate the forces in a structure and structural elements due to earthquake

CO5 Design earthquake resistant building structures

TEXTBOOKS:

1. Anil K. Chopra, “Dynamics of structures - Theory and Applications to Earthquake Engineering”, Prentice Hall Inc., 2007.
2. Mario Paz, “Structural Dynamics - Theory and Computations”, Fifth Edition, 2nd Printing, CBS Publishers, 2006.
3. Agarwal P. and Shrikhande M., “Earthquake Resistant Design of Structures”, Prentice Hall of India Pvt. Ltd., 2011.

REFERENCES:

1. Clough R. W. and Penzien J., “Dynamics of Structures”, Second Edition, McGraw Hill International Edition, 1995.
2. Minoru Wakabayashi, “Design of Earthquake Resistant Buildings”, McGraw Hill Book Company, 1986.
3. Madhujit Mukhopadhyay, “Structural Dynamics: Vibrations and Systems”, ANE Books, 2008.
4. Moorthy C. V. R., “Earthquake Tips”, NICEE, IIT Kanpur, 2002.

Publication of Bureau of Indian Standards:

1. IS 4326: 2013, “Earthquake Resistant Design and Construction of Buildings - Code of Practice”.
2. IS 1893: 2016, “Criteria for Earthquake Resistant Design of Structures - Part 1 - General Provisions and Buildings”.

3. IS 13920: 2016, “Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces - Code of Practice”.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	2	1	1	1	1	1	1	1	3	2	2
2	3	3	3	2	1	1	2	1	1	1	1	2	3	3	2
3	3	3	3	2	1	2	3	2	2	2	1	2	3	3	3
4	3	3	3	3	2	1	1	1	2	2	1	1	3	3	3
5	3	3	3	3	2	2	3	2	2	2	1	2	3	3	3
Avg.	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**3**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5035 INTRODUCTION TO FINITE ELEMENT METHOD L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Historical background - Mathematical modeling of field problems in engineering - Governing equations - Discrete and continuous models - Boundary, initial and eigen value problems - Weighted residual methods - Variational formulation of boundary value problems - Ritz technique.

UNIT II STIFFNESS MATRIX FORMULATION 9

Introduction to discrete and continua elements - Direct stiffness method - Special characteristics of stiffness matrix - Assemblage of elements - Boundary condition & reaction - Equilibrium equations - Strain displacement relation - Linear constitutive relation - Stiffness matrix formulation of 2D truss element - 2D beam element - Plane frame element - Numerical methods in finite element analysis - Gauss elimination method.

UNIT III ONE DIMENSIONAL PROBLEMS 9

One dimensional second order equations - Discretization - Element types - Linear and higher order elements - Continua elements - Displacement models - Convergence requirements - Natural coordinate systems - Shape function - Interpolation function - Linear and quadratic elements - Lagrange and serendipity elements - Strain displacement matrix - Element stiffness matrix and nodal load vector - Natural frequencies of longitudinal vibration and mode shapes.

UNIT IV TWO DIMENSIONAL PROBLEMS 9

Two dimensional isoparametric elements - Four noded quadrilateral elements - Triangular elements - Computation of stiffness matrix for isoparametric elements - Numerical integration (Gauss quadrature) - Convergence criteria for isoparametric elements.

UNIT V ANALYSIS OF PLATES 9

Introduction to plate bending problems - Displacement functions - Analysis of thin plate - Analysis of thick plate - Analysis of skew plate - Finite element analysis of shell, plane stress and plane strain analysis - Example problem using any general-purpose finite element software.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basics of finite element formulation

CO2 Formulate the stiffness matrix for beam, truss and framed structures

CO3 Apply finite element formulations to solve one-dimensional problems
CO4 Apply finite element method to solve two dimensional problems
CO5 Apply finite element method to analyze plate bending problems

TEXTBOOKS:

1. Rao S. S., "The Finite Element Method in Engineering", 6th Edition, Butterworth Heinemann, 2018.
2. Reddy J. N., "Introduction to the Finite Element Method", 4th Edition, Tata McGraw Hill, 2018.

REFERENCES:

1. Krishnamoorthy C. S., "Finite Element Analysis - Theory and Programming", McGraw Hill, 1995.
2. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
3. G. R. Liu and S. S. Quek, "Finite Element Method: A Practical Course", Butterworth-Heinemann, 1st edition, 2003.
4. Chennakesava R. Alavala, "Finite Element Methods: Basic Concepts and Applications", Prentice Hall Inc., 2010.
5. R. T. Chandrupatla and A. D. Belegundu, "Introduction to Finite Elements in Engineering", PHI Learning Pvt. Ltd., New Delhi, 1997.
6. S. S. Bhavikatti, "Finite Element Analysis", New Age Publishers, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2	3	-	-	3	-	1	1	3	2	2
2	3	3	3	2	1	2	-	-	3	-	1	1	3	2	2
3	3	3	3	2	2	2	-	-	3	-	2	1	3	2	2
4	2	3	3	2	2	2	-	-	3	-	1	2	3	2	2
5	3	3	3	2	3	2	-	-	3	-	1	2	3	2	2
Avg.	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**3**	**-**	**1**	**2**	**3**	**2**	**2**

• 1' = Low; '2' = Medium; '3' = High

VERTICAL II: CONSTRUCTION TECHNIQUES AND PRACTICES

CE5036 CONSTRUCTION EQUIPMENT AND MACHINERY L T P C
3 0 0 3

UNIT I CONSTRUCTION EQUIPMENTS 9

Identification - Planning of equipment - Selection of equipment - Equipment management in projects - Maintenance management - Equipment cost - Operating cost - Cost control of equipment - Depreciation analysis - Replacement analysis - Safety management.

UNIT II EQUIPMENT FOR EARTHWORK 9

Fundamentals of earthwork operations - Earth moving operations - Types of earthwork equipment - Tractors, motor graders, scrapers, front end waders - Dozer, excavators, rippers, loaders, trucks and hauling equipment, compacting equipment, finishing equipment - Case studies on earthwork equipment.

UNIT III OTHER CONSTRUCTION EQUIPMENT 9

Equipment for dredging, trenching, drag line and clamshells, tunneling - Jacking equipment - Equipment for drilling and blasting - Pile driving equipment - Erection equipment - Crane, mobile crane - Types of pumps used in construction - Equipment for dewatering, grouting and demolition.

UNIT IV ASPHALT AND CONCRETE PLANTS 9

Aggregate production - Different crushers - Feeders - Screening equipment - Handling equipment - Batching and mixing equipment - Ready mix concrete equipment, concrete pumping equipment - Asphalt plant - Asphalt pavers - Asphalt compacting equipment.

UNIT V MATERIALS HANDLING EQUIPMENT 9

Forklifts and related equipment - Portable material bins - Material handling conveyors - Material handling cranes - Industrial trucks - Aerial transporting equipment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Develop knowledge on planning of equipment and selection of equipment
CO2 Explain the knowledge on fundamentals of earth work operations, earth moving operations and types of earth work equipment
CO3 Develop the knowledge on special construction equipment
CO4 Apply the knowledge on asphalt and concrete plants
CO5 Apply the knowledge and select the proper materials handling equipment

TEXTBOOKS:

1. Peurifoy, R.L., Schexnayder, C., Schmitt, R.L. and Aviad Shapira., Construction Planning, Equipment and Methods, 9th Edn. McGraw Hill, Singapore, 2018.
2. Granberg G.,Popescu M Construction Equipment and Management for Engineers Estimators and Owners, Taylor and Francis Publishers, New York, 2006.

REFERENCES:

1. Deodhar, S.V. Construction Equipment and Job Planning, 4th Edn. Khanna Publishers, New Delhi, 2020.
2. Arora S.P. and Bindra S.P., Building Construction, Planning Techniques and Method of Construction, Dhanpat Rai and Sons, 2018.
3. Sharma S.C. Construction Equipment and Management, Khanna Publishers, New Delhi, 2008.
4. Dr. Mahesh Varma., Construction Equipment and its Planning and Application, Metro-politan Book Company, New Delhi., 2003.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	2	2	3	2	2	3	2	2	2	3	2	3
2	3	3	2	2	3	2	2	2	2	2	3	3	2	2	3
3	2	3	2	2	2	3	2	2	3	2	2	2	2	3	2
4	2	2	3	3	2	3	3	2	3	2	2	2	3	2	3
5	3	2	3	2	3	2	3	3	3	2	2	2	2	2	3
Avg.	**2**	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5037 CONSTRUCTION PROJECT MANAGEMENT THROUGH LEAN CONCEPTS

L T P C
3 0 0 3

UNIT I FUNDAMENTALS OF CONSTRUCTION PROJECT MANAGEMENT 9

Introduction of construction project management - Construction scope - Construction project characteristics - Project development and life cycle - Construction project management practice - Roles and functions and responsibility of construction managers and major causes of project failure.

UNIT II CONSTRUCTION PLANNING 9

Basic concepts in the development of construction plans - Choice of technology and construction method - Defining work tasks - Definition - Precedence relationships among activities - Estimating activity durations - Estimating resource requirements for work activities - Coding systems.

UNIT III SCHEDULING PROCEDURES AND TECHNIQUES 9

Introduction - Project scheduling - Bar charts - CPM / PERT - Calculations for critical path scheduling - Activity float and schedules - Presenting project schedules - Use of advanced scheduling techniques - Project monitoring and control system - Resource levelling and allocation - Crashing of network.

UNIT IV LEAN CONCEPTS, TOOLS AND TECHNIQUES 9

Concepts in lean thinking - Principles of lean construction - Variability and its impact - Traditional construction and lean construction - Traditional project delivery - Lean construction and workflow reliability - Work structuring - Lean tools and techniques - Value stream mapping - Work sampling - Last planner system - Flow and pull based production - Last planner system - Look ahead schedule - Constraint analysis - Weekly planning meeting - Daily huddles - Root cause analysis - Continuous improvement - Just in time.

UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY 9

Lean construction implementation - Enabling lean through information technology - Lean in design - Design structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) - Sustainability through lean construction approach.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Perform formulations of projects
CO2 Develop project planning strategies
CO3 Prepare the activity schedule for the construction projects
CO4 Apply lean techniques to achieve sustainability in construction projects
CO5 Apply lean construction techniques in design and modeling

TEXTBOOKS:

1. Albert Lester, Project Management, Planning and Control, 7th Edition, Butterworth- Heinemann, USA, 2017.

REFERENCES:

1. Barcus S. W. and Wilkinson J. W., “Handbook of Management Consulting Services”, McGraw Hill, New York, 1986.
2. Joy P. K., “Total Project Management - The Indian Context”, New Delhi, Macmillan India Ltd., 1992.
3. Corfe C. and Clip B., “Implementing Lean in Construction: Lean and the Sustainability Agenda”, CIRIA, 2013.
4. Shang Gao and Sui Pheng Low, “Lean Construction Management: The Toyota Way”, Springer, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	1	2	2	1	3	2	3	2	3	3	3
2	3	2	3	2	2	2	2	1	3	1	3	2	3	3	3
3	3	3	2	3	3	2	2	1	2	1	3	2	3	3	3
4	3	2	3	2	2	2	2	1	3	2	3	2	3	3	3

5	3	2	2	2	3	2	2	1	3	2	3	2	3	3	3
Avg.	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**3**	**2**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5038 CONSTRUCTION QUALITY AND SAFETY L T P C
3 0 0 3

UNIT I CONSTRUCTION QUALITY MANAGEMENT 9

Importance of construction quality - Elements of quality - Quality characteristics - Quality by design - Quality conformance - Contractor quality control - Identification and traceability - Continuous chain management - Brief concept and application - Importance of specifications - Incentives and penalties in specifications - Workmanship as a mark of construction quality - Final inspection.

UNIT II CONSTRUCTION QUALITY ASSURANCE AND CONTROL 9

Construction quality assurance techniques - Inspection, testing, sampling - Documentation - Organization for quality control - Cost of quality - Introduction to TQM, Six Sigma concept in construction industry.

UNIT III CONSTRUCTION ACCIDENTS 9

Accidents and their causes - Human factors in construction safety - Costs of construction injuries - Occupational and safety hazard assessment - Problem areas in construction safety.

UNIT IV SAFETY DURING CONSTRUCTION 9

Basic terminology in safety - Types of injuries - Safety pyramid - Accident patterns - Planning for safety budget, safety culture - Introduction to OSHA regulations - Site safety programs - Job hazard analysis, accident investigation and accident indices - Violation, penalty.

UNIT V SAFE OPERATING PROCEDURES 9

Safety during alteration, demolition works - Earthwork, steel construction, temporary structures, masonry and concrete construction, cutting and welding - Construction equipment, materials handling disposal and hand tools - Other hazards - Fire, confined spaces, electrical safety.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Apply the quality standards for preparing quality system documents
CO2 Select the techniques and tools for quality assurance and control in construction
CO3 Develop the knowledge on accidents and their causes
CO4 Develop the knowledge about safety programmes and job-site safety assessment
CO5 Apply knowledge while designing for safety and safety procedures

TEXTBOOKS:

1. Juran Frank, J.M. and Gryna, F.M. Quality Planning and Analysis, McGraw Hill, 2001.

REFERENCES:

1. K. B. Rajoria, Deepak Naryan and Deepak Gupta, "Practices in Construction", CBS Publishers & Distributors Pvt. Ltd., ISBN:978-93-90709-33-5, 2021.
2. Bhattacharjee S. K., "Safety Management in Construction (Principles and Practice)", Khanna Publishers, New Delhi, 2011.
3. Albert Lester, "Project Management, Planning and Control", 7th Edition, Butterworth-Heinemann, USA, 2017.
4. Patrick X. W. Zou, Riza Yosia Sunindijo, "Strategic Safety Management in Construction and Engineering", John Wiley & Sons Ltd., 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	2	2	2	2	1	2	2	2	2	3	3	3
2	3	3	2	2	2	2	2	1	2	1	2	2	3	3	3
3	3	2	3	2	2	2	2	1	2	1	2	2	3	3	3
4	3	3	2	2	2	2	2	1	2	2	2	2	3	3	3
5	3	3	3	2	2	2	2	1	2	2	2	2	3	3	3
Avg.	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5039 ADVANCED CONSTRUCTION TECHNIQUES L T P C
3 0 0 3

UNIT I SUB STRUCTURE CONSTRUCTION 9

Construction methodology - Box jacking - Pipe jacking - Under water construction of diaphragm walls and basement - Tunneling techniques - Piling techniques - Driving well and caisson - Sinking cofferdam - Cable anchoring and grouting - Driving diaphragm walls, sheet piles - Laying operations for built up offshore - Well points - Dewatering for underground open excavation.

UNIT II SUPER STRUCTURE CONSTRUCTION FOR BUILDINGS 9

Vacuum dewatering of concrete flooring - Concrete paving technology - Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections - Erection techniques of tall structures, large span structures - Launching techniques for heavy decks - In-situ prestressing in high rise structures - Post tensioning of slab - Aerial transporting.

UNIT III CONSTRUCTION OF SPECIAL STRUCTURES 9

Erection of lattice towers - Rigging of transmission line structures - Construction sequence in cooling towers, silos, chimney, sky scrapers - Bow string bridges, cable stayed bridges - Launching and pushing of box decks - Construction of jetties and break water structures - Construction sequence and methods in domes - Erection of articulated structures and space decks.

UNIT IV REHABILITATION AND STRENGTHENING TECHNIQUES 9

Seismic retrofitting - Strengthening of beams - Strengthening of columns - Strengthening of slab - Strengthening of masonry wall - Protection methods of structures - Mud jacking and grouting for foundation - Micro piling and underpinning techniques - Sub grade water proofing - Soil stabilization techniques.

UNIT V DEMOLITION 9

Demolition techniques - Demolition by machines - Demolition by explosives - Advanced techniques using robotic machines - Demolition sequence - Dismantling techniques - Safety precaution in demolition and dismantling.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the modern construction techniques used in the sub structure construction

CO2 Demonstrate knowledge and understanding of the principles and concepts relevant to super structure construction for buildings

CO3 Understand the concepts used in the construction of special structures
CO4 Knowledge on various strengthening and repair methods for different cases
CO5 Identify the suitable demolition technique for demolishing a building

TEXTBOOKS:

1. Sarkar, S.K. and Saraswati, S., Construction Technology, Oxford University, New Delhi, 2008.

REFERENCES:

1. Jerry Irvine, "Advanced Construction Techniques", CA Rocket, 1984.
2. Patrick Powers J., " Construction Dewatering: New Methods and Applications", John Wiley & Sons, 1992.
3. Peter H. Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications Pvt. Ltd., 2008.
4. Robertwade Brown, " Practical Foundation Engineering Handbook", McGraw Hill Publications, 1995.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	3	3	2	2	-	1	1	2	1	3	2	3
2	1	-	-	2	2	2	3	-	1	1	2	1	2	3	2
3	2	3	3	2	3	3	2	1	2	2	3	2	3	3	3
4	2	3	3	3	2	1	2	1	1	1	2	1	3	3	3
5	1	3	3	3	2	2	1	1	2	2	3	2	2	3	2
Avg.	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**2**	**1**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5040 ENERGY EFFICIENT BUILDINGS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Climate adapted and climate rejecting buildings - Heat transfer - Measuring conduction - Thermal storage - Measurement of radiation - The greenhouse effect - Convection - Measuring latent and sensible heat - Psychrometry chart - Thermal comfort - Microclimate, site planning and development - Temperature - Humidity - Wind - Optimum site locations - Sun path diagrams - Sun protection - Types of shading devices - Design responses to energy conservation strategies.

UNIT II PASSIVE SOLAR HEATING AND COOLING 9

General principles of passive solar heating - Key design elements - Sunspace - Direct gain - Trombe walls, water walls - Convective air loops - Concepts - Case studies - General principles of passive cooling - Ventilation - Principles - Case studies - Courtyards - Roof ponds- Cool pools predicting ventilation in buildings - Window ventilation calculations - Room organization strategies for cross and stack ventilation - Radiation - Evaporation and dehumidification - Wind catchers - Mass effect - Air filtration and odor removal.

UNIT III DAYLIGHTING AND ELECTRICAL LIGHTING 9

Materials, components and details - Insulation - Optical materials - Radiant barriers - Glazing materials - Glazing spectral response - Day lighting - Sources and concepts - Building design strategies - Daylight apertures - Light shelves - Codal requirements - Day lighting design - Electric lighting - Light distribution - Electric lighting control for day lighted buildings - Switching controls - Coefficient of utilization - Electric task lighting - Electric light zones - Power adjustment factors.

UNIT IV HEAT CONTROL AND VENTILATION 9

Hourly solar radiation - Heat insulation - Terminology - Requirements - Heat transmission through building sections - Thermal performance of building sections - Orientation of buildings - Building characteristics for various climates - Thermal design of buildings - Influence of design parameters - Ventilation - Requirements - Ventilation design - Energy conservation in ventilating systems - Design for natural ventilation - Calculation of probable indoor wind speed.

UNIT V DESIGN FOR CLIMATIC ZONES 9

Energy efficiency - An overview of design concepts and architectural interventions - Embodied energy - Low embodied energy materials - Passive downdraft evaporative cooling - Design of energy efficient buildings for various zones - Various climatic conditions - Case studies of residences, office buildings and other buildings in each zones - Commonly used software packages in energy efficient building analysis and design - Energy audit - Certification.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain environmental energy supplies on buildings
CO2 Explain the passive solar heating, cooling system
CO3 Discuss the various aspects of day-lighting and electrical lighting in abuilding
CO4 Predict and design building ventilation and heat control for indoor comfort
CO5 Design a building for climatic zone and apply simulation programs of buildings to perform energy calculations

TEXTBOOKS:

1. Brown, G.Z. and DeKay, M., Sun, Wind and Light - Architectural Design Strategies, John nd Sons Inc,3rd Edition, 2014.

REFERENCES:

1. "Energy Conservation Building Code", cau of Energy Efficiency, New Delhi, 2018.
2. "Handbook on Functional Requirements of Buildings Part 1 to 4 SP: 41 (S and T)", 1995.
3. "Residential Energy: Cost Savings and Comfort for Existing Buildings", John Krigger and Chris Dorsi, Published by Saturn Resource Management, 2013.
4. Majumdar M. (Ed.), "Energy - Efficient Buildings in India", Tata Energy Research Institute, Ministry of Non-Conventional Energy Sources, 2009.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	2	-	-	3	3	2	1	-	-	3	3	2	1
2	3	-	2	-	-	3	3	-	-	-	-	-	3	2	1
3	3	-	2	-	-	3	3	-	-	-	-	-	3	2	2
4	3	3	3	-	-	3	3	-	-	1	-	-	3	3	3
5	3	3	3	1	2	3	3	2	-	1	-	-	2	3	3
Avg.	3	2	3	2	1	3	3	2	1	1	-	3	3	3	3

• 1' = Low; '2' = Medium; '3' = High

CE5041 DIGITALIZED CONSTRUCTION LAB L T P C
0 0 6 3

LIST OF EXPERIMENTS:

To implement the digital knowledge in construction (use relevant softwares)

1. Introduction and understanding of Primavera project planner for construction
2. Using Primavera project planner, update the schedule of the project of a construction project
3. Introduction and understanding of MS Project for a construction project
4. Using MS project, schedule the construction project planning
5. Introduction to BIM in construction projects
   Development of BIM for small construction project
6. Progress the work flows in construction project using BIM
7. Development of bid management for a small firm construction industry using software.

TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the importance of latest softwares in a construction industry
CO2 Plan a construction project using Primarvera
CO3 Plan a construction project using MS project
CO4 Develop a BIM information model
CO5 Analyze the bid management and its effectiveness using bid management software

REFERENCES:

1. Kenneth C Laudon and Jane Price Laudon, Management Information Systems Organization and Technology, Prentice Hall, 1996.
2. Kathy Schwalbe, information Technology Project management, CENGAGE Learning Custom Publishing, 6th Revised Edn, 2010.
3. Vinayagam P, Vimala A, Planning and Managing Projects with Primavera (P6) Project Planner, I K International Publishing House, Pvt. Ltd, 2017.
4. Paul E, Harris, Planning and Control using Microsoft Project 2013, 2016 & 2019, Eastwood Harris Pvt Ltd, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	2	3	3	2	2	3	2	2	2	3	2	3
2	3	3	2	2	3	2	2	2	2	2	3	3	2	2	3
3	2	3	2	2	3	3	2	2	3	2	2	2	2	3	2
4	2	2	3	3	3	3	3	2	3	2	3	3	3	2	3
5	3	2	3	2	3	2	3	3	3	2	3	3	2	2	3
Avg.	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

VERTICAL III: GEOTECHNICAL

CE5023 GEO-ENVIRONMENTAL ENGINEERING L T P C
3 0 0 3

UNIT I GENERATION OF WASTES AND CONSQUENCES OF SOIL POLLUTION 8

Introduction to Geo environmental engineering - Environmental cycle - Sources, production and classification of waste - Causes of soil pollution - Factors governing soil pollution interaction clay minerals - Failures of foundation due to waste movement.

UNIT II SITE SELECTION AND SAFE DISPOSAL OF WASTE 10

Safe disposal of waste - Site selection for landfills - Characterization of land fill sites and waste - Risk assessment - Stability of landfills - Current practice of waste disposal - Monitoring facilities - Passive containment system - Application of geosynthetics in solid waste management - Rigid or flexible liners.

UNIT III TRANSPORT OF CONTAMINANTS 8

Contaminant transport in sub surface - Advection, Diffusion, Dispersion - Governing equations - Contaminant transformation - Sorption - Biodegradation - Ion exchange - Precipitation - Hydrological consideration in land fill design - Ground water pollution.

UNIT IV WASTE STABILIZATION 10

Stabilization - Solidification of wastes - Micro and macro encapsulation - Absorption, Adsorption, Precipitation - Detoxification - Mechanism of stabilization - Organic and inorganic stabilization - Utilization of solid waste for soil improvement.

UNIT V REMEDIATION OF CONTAMINATED SOILS 9

Exsitu and insitu remediation-Solidification, bio-remediation, incineration, soil washing, electro kinetics, soil heating, vetrification, bio-venting.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1 understand basic knowledge of concepts and principles of Geo-environmental Engineering
CO2 Select site for safe disposal of waste
CO3 Be aware of soil stabilization by utilizing solid waste
CO4 Assess the contamination in the soil and to select suitable remediation methods based on contamination
CO5 Prepare the suitable disposal system for particular waste

TEXTBOOKS:

1. Manoj Datta, “Waste Disposal in Engineered landfills”, Narosa Publishing House, 1997.
2. Manoj Datta, B.P. Parida, B.K. Guha, “Industrial Solid Waste Management and Landfilling Practice”, Narosa Publishing House, 1999.

REFERENCES:

1. Hari D. Sharma and Krishna R. Reddy, “Geo-Environmental Engineering” -John Wiley and Sons, INC, USA, 2004.
2. Daniel B.E., “Geotechnical Practice for waste disposal”, Chapman & Hall, London 1993.
3. Westlake, K, “Landfill Waste pollution and Control”, Albion Publishing Ltd., England, 1995.
4. Wentz, C.A., “Hazardous Waste Management”, McGraw Hill, Singapore, 1989.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	3	3	3	3	3	2	2	2	3	2	3	3
2	3	2	3	3	3	2	3	2	2	2	2	3	2	2	3
3	3	2	2	3	2	3	2	3	2	2	2	3	2	2	3
4	2	3	3	3	2	3	3	3	2	2	2	3	2	2	2
5	3	3	2	2	2	2	2	2	2	2	2	3	3	2	3

Avg.	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5024 GROUND IMPROVEMENT TECHNIQUES L T P C
3 0 0 3

UNIT I PROBLEMATIC SOIL AND IMPROVEMENT TECHNIQUES 8

Geotechnical problems in alluvial, lateritic and black cotton soils - Role of ground improvement in foundation engineering - Methods of ground improvement - Selection of suitable ground improvement techniques based on soil conditions.

UNIT II DEWATERING 10

Dewatering Techniques - Well points - Vacuum and electroosmotic methods - Seepage analysis for two-dimensional flow for fully and partially penetrated slots in homogeneous deposits - Design for simple cases.

UNIT III INSITU TREATMENT OF COHESIONLESS AND COHESIVE SOILS 10

Insitu densification of cohesionless soils - Dynamic compaction - Vibroflotation, Sand compaction piles and deep compaction. Consolidation of cohesionless soils - Preloading with sand drains, and fabric drains, Stabilization of soft clay ground using stone columns and Lime piles-Installation techniques - Simple design - Relative merits of above methods and their limitations.

UNIT IV EARTH REINFORCEMENT 9

Concept of reinforcement - Types of reinforcement material - Reinforced earth wall - Mechanism - Simple design - Applications of reinforced earth; Functions of Geotextiles in filtration, drainage, separation, road works and containment applications.

UNIT V GROUTING TECHNIQUES AND SOIL STABILIZATION 8

Types of grouts - Grouting equipment and machinery - Injection methods - Grout monitoring - Stabilization with cement, lime, chemicals and industrial wastes - Stabilization of expansive soil.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Identify various problems associated with soil deposits and selection of ground improvement methods

CO2 Understand dewatering techniques and design for simple cases as per needs and specifications.

CO3 Understand the concept involved for in-situ treatment of cohesive and cohesionless soils and design for simple cases

CO4 Appreciate the concept of earth reinforcement and its applications and design for simple cases in various engineering structure.

CO5 Understand the soil grouting and stabilization techniques

TEXTBOOKS:

1. Purushothama Raj. P, "Ground Improvement Techniques", Firewall Media, 2005.
2. Bikash Chandra chattopadhyay and Joyanta Maity, " Ground Improvement Techniques", PHI Learning Pvt. Ltd., 2017.

REFERENCES:

1. Koerner, R.M. "Construction and Geotechnical Methods in Foundation Engineering", McGraw Hill, 1994.
2. Moseley, M.P., "Ground Improvement", Blockie Academic and Professional, Chapman and Hall, Glasgow, 2004.
3. Winterkorn, H.F. and Fang, H.Y. "Foundation Engineering Hand Book". Van Nostrand Reinhold, 1994.

4. Koerner, R.M., “Designing with Geosynthetics” (Fourth Edition), Prentice Hall, Jersey, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	3	3	3	3	2	2	2	3	2	3	2
2	3	3	2	3	3	2	2	2	2	2	2	3	2	2	2
3	3	2	2	3	3	3	2	2	2	2	2	3	2	2	2
4	2	3	3	3	2	3	3	2	2	2	2	3	2	2	2
5	3	3	2	2	3	2	2	2	2	2	2	3	3	2	3
Avg.	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5025 SOIL DYNAMICS AND MACHINE FOUNDATIONS L T P C
3 0 0 3

UNIT I THEORY OF VIBRATION 9

Nature dynamic loads - Vibrations of single degree freedom system - Free vibrations of spring - mass systems - Forced vibrations - Viscous damping - Transmissibility - Principles of vibration measuring instruments - Effect of Transient and Pulsating loads

UNIT II WAVE PROPAGATION 9

Elastic waves in rods of infinite length - Longitudinal and Torsional - Effect of end conditions - Longitudinal and torsional vibrations of rods of finite length - Wave Propagation in infinite, homogeneous isotropic and elastic medium - Wave propagation in elastic half space - Typical values of compression wave and shear wave velocity - Wave propagation due to Machine foundation - Surface wave - Typical values - Particle movements and velocity.

UNIT III DYNAMIC PROPERTIES OF SOILS 9

Dynamic stress - Strain characteristics - Principles of measuring dynamic properties - Laboratory Techniques - Field tests - Factors affecting dynamic properties - Typical values - Dynamic bearing capacity - Dynamic earth pressure.

UNIT IV FOUNDATION FOR DIFFERENT TYPES OF MACHINES 9

Types of machines and foundation - General requirements - Modes of vibration of a rigid foundation - Method of analysis - Linear elastic weightless spring method - Elastic half space method - Analog Method - Design of block foundation - Special consideration for rotary, Impact type of machines - Codal Provisions.

UNIT V INFLUENCE OF VIBRATION AND REMEDIATION 9

Mechanism of Liquefaction - Influencing factors - Evaluation of Liquefaction potential based on SPT- Force Isolation - Motion Isolation - Use of spring and damping materials - Vibration control of existing machine foundation - Screening of vibration - Open trenches - Pile Barriers - Salient construction aspects of machine Foundations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 understand the basic knowledge about the theory of vibration.
CO2 understand the different types of waves and its behaviour.

CO3 acquire knowledge about various laboratory and field tests to determine the dynamic soil properties and its interpretation.
CO4 Understand the types of machines and foundation and simple design of machine foundation
CO5 assess the influence of vibrations and selection of remediation methods based on the nature of vibration, properties and behaviour of soil.

TEXT BOOKS:

1. Swamisaran, "Soil Dynamics and Machine Foundations", Galgotia Publications Pvt.Ltd. (Second Edition) 2006, (Reprint 2010), New Delhi-110002
2. Srinivasulu. P, and Vaidyanathan. C. V, "Handbook of Machine Foundations", Tata McGraw-Hill, 2007

REFERENCES:

1. Kamaswara Rao., "Vibration Analysis and Foundation Dynamics", Wheeler Publishing, New Delhi, 1998.
2. Kameswara Rao., "Dynamics Soil Tests and Applications", Wheeler Publishing, New Delhi, 2003.
3. Moore, P.J., "Analysis and Design of Foundation for Vibration", Oxford and IBH, 2005
4. Steven L. Kramer, "Geotechnical Earthquake Engineering", Prentice Hall, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	3	3	3	3	3	2	2	2	3	2	3	2
2	3	3	3	3	2	2	3	2	2	2	2	3	2	2	3
3	3	2	3	3	2	3	2	2	2	2	2	3	2	2	3
4	2	3	3	3	2	3	3	2	2	2	2	3	2	2	2
5	3	3	2	2	3	2	2	2	2	2	2	3	3	2	3
Avg.	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5026 **ROCK MECHANICS** **L T P C**
3 0 0 3

UNIT I CLASSIFICATION AND INDEX PROPERTIES OF ROCKS 6

Geological classification - Index properties of rock systems - Classification of rock masses for engineering purpose - Rock Mass Rating and Q System.

UNIT II ROCK STRENGTH AND FAILURE CRITERIA 12

Modes of rock failure - Strength of rock - Laboratory measurement of shear, tensile and compressive strength. Stress - strain behaviour of rock under compression - Mohr -Coulomb failure criteria and empirical criteria.

UNIT III INITIAL STRESSES AND THEIR MEASUREMENTS 10

Estimation of initial stresses in rocks - influence of joints and their orientation in distribution of stresses - measurements of in-situ stresses - Hydraulic fracturing - Flat jack method - Over coring method.

UNIT IV APPLICATION OF ROCK MECHANICS IN ENGINEERING 10

Simple engineering application - Underground openings - Rock slopes - Foundations and mining subsidence.

UNIT V ROCK STABILISATION *7*

Introduction - Rock support and Rock reinforcement - Principles - Support reaction curves -

Shotcreting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the characterization and rating the rock mass.
CO2 Arrive at the behaviour of rock for the given project.
CO3 Calculate the insitu stresses of rock.
CO4 Design underground excavation, open excavation and sub-structures.
CO5 Design suitable support system under unstable condition.

TEXTBOOKS:

1. Goodman, P.E. “Introduction to Rock Mechanics”, John Wiley and Sons, 1999.
2. Ramamurthy. T., “Engineering in Rocks for Slopes, Foundation and Tunnels”, Third Edition, PHI Learning Private Limited, New Delhi, 2014.

REFERENCES:

1. Brown, E.T. “Rock Characterization Testing and Monitoring”. Pergaman Press 1991.
2. Arogyaswamy, R.N.P., “Geotechnical Application in Civil Engineering”, Oxford and IBH, 1991.
3. Hook E. and Bray J., “Rock slope Engineering, Institute of Mining and Metallurgy”, U.K. 2004.
4. Brady, B.H.G. and Brown, E.T., “Rock mechanics for underground mining”, Third Edition, Kluwer Academic Publishers, Dordrecht, 2006.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	3	3	3	3	3	2	2	2	3	2	3	2
2	3	3	3	3	2	2	3	2	2	2	2	3	2	2	3
3	3	2	3	3	2	3	2	2	2	2	2	3	2	2	3
4	2	3	3	3	2	3	3	2	2	2	2	3	2	2	2
5	3	3	2	2	3	2	2	2	2	2	2	3	3	2	3
Avg.	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5042 EARTH AND EARTH RETAINING STRUCTURES L T P C
3 0 0 3

UNIT I EARTH PRESSURE THEORIES 9

State of stress in retained soil mass - Earth pressure theories - Classical and graphical techniques (Culmann’s method) - Active and passive cases - Earth pressure due to external loads.

UNIT II STABILITY OF RETAINING STRUCTURES 9

Retaining structure - Selection of soil parameters - Lateral pressure due to compaction, strain softening, wall flexibility, drainage arrangements and its influence.

UNIT III SHEET PILE WALLS 9

Types of sheet piles - Analysis and design of cantilever and anchored sheet pile walls - free earth support method - fixed earth support method.

UNIT IV SUPPORTED EXCAVATIONS 9

Lateral pressure on sheeting in braced excavation, stability against piping and bottom heaving. Soil anchors and Soil pinning -Basic design concepts - Slurry Supported Trenches-Diaphragm walls - Basic principles and construction techniques.

UNIT V STABILITY OF SLOPES 9

Stability of infinite and finite slopes, Limit Equilibrium method, Wedge analysis, Method of Slices, Bishop's method, Janbu's method. Role of geosynthetics in stabilization of slopes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Analyse the earth pressure acting on retaining structures by applying classical theories and graphical techniques

CO2 Apply the knowledge of engineering to analyse earth pressure and design rigid retaining structures considering effect of compaction, wall flexibility, pore water pressure

CO3 Analyse and design flexible earth retaining walls using free and fixed earth support

CO4 Apply the knowledge on lateral earth pressure behind and around excavation to analyse and design braced excavations and slurry supported excavations

CO5 Analyse the stability of infinite and finite slopes through total stress and effective stress analysis by considering the actual shape of failure surface expected in the field

TEXTBOOKS:

1. Clayton, C.R.I., Militisky, J. and Woods, R.I., Earth pressure and Earth-Retaining structures, ThirdEdition, CRC Press Taylor & Francis Group, 2013.
2. Das, B.M., Principles of Geotechnical Engineering, Eighth Edition, Cengage Learning, 2014.
3. Militisky, J. and Woods, R., Earth and Earth retaining structures, Third Edition, CRC Press Taylor & Francis Group, 2013.

REFERENCES:

1. Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Handbook, Galgotia Book- source, 2010.
2. Day, R.W., Geotechnical and Foundation Engineering: Design and Construction, McGraw Hill, 1999.
3. Mandal, J.N., Reinforced Soil and Geotextiles, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1993.
4. McCarthy, D.F., Essentials of Soil Mechanics and Foundations: Basic Geotechnics, Seventh Edition, Prentice Hall, 2006.
5. Hajnal, I., Marton, J. and Regele, Z., Construction of diaphragm walls, A Wiley - Interscience Publication, 1984.
6. Petros P. Xanthakos., Slurry walls as structural systems, McGraw-Hill, Inc., New York, 2016.
7. Bramhead, E.N., The Stability of Slopes, Blacky Academic and Professionals Publications, Glasgow, 1986.
8. Muni Budhu, Soil Mechanics and Foundation, John Wiley and Sons, INC 2007.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	b	3	2	2	3	3	2	3	2	2	2	3	2	3	2
2	3	3	3	2	2	2	2	2	2	2	2	3	2	2	3
3	3	3	3	2	2	3	2	2	2	2	2	3	2	2	3
4	2	3	3	3	2	3	3	2	2	2	2	3	2	2	2
5	3	2	2	2	3	2	2	2	2	2	2	3	3	2	3
Avg.	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5043 PILE FOUNDATIONS L T P C
3 0 0 3

UNIT I PILE CLASSIFICATIONS AND LOAD TRANSFER PRINCIPLE 10

Necessity of pile foundation - classification of piles - Factors governing choice of type of pile - Load transfer mechanism - effect of pile installation on soil condition - criteria for pile socketing - responsibility of engineer and contractor

UNIT II AXIAL LOAD CAPACITY OF PILES AND PILE GROUP 10

Allowable load capacity of piles and pile groups - Static and dynamic methods - for cohesive and cohesionless soil - negative skin friction - group efficiency -Settlement of piles and pile group -IS codal provisions and IRC guide lines.

UNIT III LATERAL AND UPLIFT LOAD CAPACITIES OF PILES 9

Piles under Lateral loads - Broms method, elastic, p-y curve analyses - Batter piles - response to moment - piles under uplift loads - under reamed piles -IS codal provision - IRC guide lines.

UNIT IV STRUCTURAL DESIGN OF PILE AND PILE GROUP 9

Structural design of pile - structural capacity - pile and pile cap connection - pile cap design - shape, depth, assessment, and amount of steel - truss and bending theory- Reinforcement details of pile and pile caps- IS codal provision - IRC guide line.

UNIT V CONSTRUCTION ASPECTS AND QUALITY CONTROL 7

Piling equipment and construction methods - Evaluation of axial load capacity from field test results -Pile load test - Pile integrity test -IS codal provision.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Classify the pile foundation along with the load transfer mechanism and piling equipment
CO2 Determine the vertical load carrying capacity and the settlement of pile and pile group
CO3 Analyse the pile subjected to lateral and uplift load with reference to codal provision
CO4 Design the pile and pile caps and provide the reinforcement details according to codal provisions
CO5 Understand the piling equipment and construction methods and evaluate the axial load capacity from field test results

TEXTBOOKS:

1. Das, B.M., Principles of Foundation Engineering, Cengage Learning India Pvt. Ltd. 2016.
2. Poulos, H.G., Davis, E.H., Pile foundation analysis and design, John Wiley and Sons, New York, 1980.
3. Tomlinson, M.J. Pile Design and Construction Practice, 4th Edition, Spon Press, New York, 2004.

REFERENCES:

1. Cernica, J.N. Geotechnical Engineering Foundation Design, John Wiley and Sons, Inc. 1995.
2. Bowles, J.E., Foundation Analysis and Design, Fifth Edition, McGraw Hill, New York, 2001.
3. Donald, P., Coduto, Foundation Design Principles and Practices, Pearson India Education Services Pvt. Ltd., 2014.
4. Varghese P.C.," Foundation Engineering", PHI Learning Private Limited, New Delhi, 2012.
5. Reese,L.C., Isenhower,W.M. and Wang,S.T. Analysis and Design of Shallow and Deep Foundations, John Wiley and Sons, New York, 2005.
6. Varghese P.C.," Limit State Design of Reinforced Concrete Foundations", PHI Learning Private Limited, New Delhi, 2011.

7. Reese, L. C. and Van Impe, W. F., Single Piles and Pile Groups Under Lateral Loading, Taylor and Francis, London, 2011.
8. Satyendra Mittal, Pile Foundation - Design and Construction including Well Foundation, CBS Publishers and Distributers Pvt. Ltd., 2019.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	3	3	2	3	2	2	2	3	2	3	2
2	3	3	3	2	2	2	2	2	2	2	2	3	2	2	3
3	3	3	3	2	2	3	2	2	2	2	2	3	2	2	3
4	2	3	3	3	2	3	3	2	2	2	2	3	2	2	2
5	3	2	2	2	3	2	2	2	2	2	2	3	3	2	3
Avg.	3	3	3	2	2	3	2	2	2	2	2	3	2	2	3

• 1' = Low; '2' = Medium; '3' = High

VERTICAL IV: GEO-INFORMATICS

GI5006 ENVIRONMENTAL GEOINFORMATICS L T P C
3 0 0 3

UNIT I WATER AND THE ENVIRONMENT 9

Sources and demands of water - Characteristics of water - Point and non-point sources of water pollution - Spectral responses of clear and contaminated water - Chlorophyll - Remote Sensing of Water quality assessment - Classification of water quality for various purposes, Sampling procedure, quality analysis, Database creation and quality modeling using GIS. Database Creation and designing water supply network, sewerage network using GIS. Runoff estimation - Flood prediction modeling - Aquifer vulnerability modeling.

UNIT II SOIL CONSERVATION AND MANAGEMENT 9

Formation of Soils - Classification - Landforms - Soil erosion - Factors influencing soil erosion, soil contamination - Distribution and accumulation of contaminants such as toxic metals, synthetic chemicals in soil - Mining pollution - Methods of conservation - Afforestation - EMR responses with contaminated soil - Modeling soil characteristics using satellite data - Soil degradation assessment using Remote Sensing and GIS - Land reclamation.

UNIT III SOLID WASTE MANAGEMENT 9

Definition - Sources - elements of integrated waste management and roles of stakeholders - Seven elements and seven step approach to integrated solid waste management planning, identification of storage and collection location - Analysis of collection route - Site selection: Transfer station, Disposal site - Waste allocation - leachate model - Case studies.

UNIT IV AIR POLLUTION 9

Structure and composition of atmosphere - Sources and classification of air pollutants, Air Quality Standards - Chemical and Physical Components - Sampling - Mapping of atmospheric pollution - Air pollution due to industrial activity - Plume behaviors - Dispersion model: Gaussian Plume model - Introduction to commonly used software-based models such as ADMS, AERMOD, CALINE, CALPUFF, DEGADIS, HYROAD, INDUSTRIAL SOURCE COMPLEX, SCREEN, HYSPLIT, INDEX etc. - Remote Sensing to monitor atmosphere constituents - Case Studies.

UNIT V SENSORS AND DATA FOR ENVIRONMENTAL MONITORING 9

Sensors for environmental monitoring - sensors - LIDAR- LASER Remote Sensing - EMR - absorption spectrometers - Selection of ground truth sites-sea truth observation - Radar techniques for sensing ocean surface - Thermal measurements - Application of remote sensing for oil slicks mapping - Chlorophyll detection - Fisheries resources - Coastal marine studies - Determination of temperature and sea state.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the possible applications of remote sensing and GIS in water quality analysis and network design

CO2 Understand the possible applications of remote sensing and for soil conservation

CO3 Understand the possible applications of remote sensing and for solid waste management

CO4 Understand the possible applications of remote sensing and for air pollution mapping and modeling

CO5 Understand the possible applications of remote sensing and for climate change perspectives

TEXT BOOKS:

1. Susan L. Ustin., "Manual of Remote Sensing: Remote Sensing for Natural Resource Management and Environmental Monitoring", John Wiley& Sons Inc, 2004.
2. Eric Charles Barrett., Leonard Frank Curtis, "Introduction to Environmental Remote Sensing, Chapman and Hall", 2nd edition, 1982.
3. Andrew N. Rencz., "Manual of Remote Sensing: Remote Sensing for Natural Resource Management and Environmental Monitoring", John Wiley & Sons Inc, 3rd Edition, 2004.
4. Baretl, E.C. and Culis I.F., "Introduction to Environmental Remote Sensing", 2nd edition, Chapman and Hall, New York, 2013.

REFERENCES:

1. Jr. Lintz, Joseph, David S. Simonett., " Remote sensing of environment Addision Wesley", 1976.
2. Martin Paegelow and María Teresa Camacho Olmedo., "Modelling Environmental Dynamics: Advances in Geomatic Solutions", Springer, 2008.
3. Jonathan Li and Xiaojun Yang., "Monitoring and Modeling of Global Changes: A Geomatics Perspective", Springer Remote Sensing/Photogrammetry, 2015.
4. Robert Scally., "GIS for Environmental Management", ESRI Press, 2006.
5. Andrew Skidmore., "Environmental Modelling with GIS and Remote Sensing", CRC Press, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	3	3	1	2	2	3	3	3	3	2
2	3	3	2	3	3	3	3	1	2	2	2	3	3	3	2
3	3	3	3	3	3	3	3	1	2	2	3	3	3	3	2
4	3	3	3	3	3	3	3	1	2	2	3	3	3	3	2
5	3	2	2	3	3	3	3	1	2	2	2	3	3	3	2
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**2**

• 1' = Low; '2' = Medium; '3' = High

GI5005 TRANSPORTATION GEOMATICS L T P C
3 0 0 3

UNIT I ENGINEERING SURVEYS AND GEOMETRIC DESIGN 9

Classification of roads and railways - Alignment surveys and investigations using conventional and remote sensing techniques (preliminary, reconnaissance and final location surveys) - Types of Highway pavements - Design principles of highway geometric elements.

UNIT II URBAN TRANSPORTATION SYSTEMS AND PLANNING 9

Urban transportation: policy alternatives - Transportation and the environment - Urban transport planning processes - Socio-demographic data and travel surveys - Transportation modelling - Traffic congestion - Plan evaluation and implementation - Planning and financing - Critiques of transportation modelling and forecasting.

UNIT III REMOTE SENSING APPLICATIONS IN TRANSPORTATION 9

Traffic analysis - Accident analysis - Site suitability analysis for transport infrastructure - Population distribution studies- Improving rural road network - Regional road network connectivity - Vehicle tracking - Incident identification and management.

UNIT IV GIS IN TRANSPORTATION ANALYSIS 9

Transportation analysis in GIS: Network flows - Shortest path algorithms: Distance and Cost-based - Transportation databases: creation and maintenance - Facility location: Catchment area analysis - Vehicle routing - Route alignment studies: Raster analysis - Highway maintenance - Case studies.

UNIT V INTEGRATED TRANSPORT MODELS 9

Land use transport interaction models - Transport environment interaction models - Intelligent Transportation Systems (ITS) - Development - Architecture - Integration with GIS, GPS, IOT - Traffic volume estimation and monitoring - Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand various highway geometric elements and surveys carried out for highway alignment
CO2 Understand the factors involved in urban transportation planning
CO3 Apply remote sensing techniques for transportation problems
CO4 Apply GIS for transportation analysis
CO5 Gain knowledge on latest developments in transportation planning

TEXT BOOKS:

1. Harvey J. Miller., Shih-Lung Shah, “Geographic Information Systems for Transportation - Principles and Applications”, Oxford University Press, 2001.
2. John Stillwell, Graham Clarke., “Applied GIS and Spatial Analysis”, John Wiley & Sons Ltd, 2004.

REFERENCES:

1. Papacostas, C.S, Prevedouros, P.D., “Transportation Engineering and Planning, Prentice- Hall India”, 2015.
2. L.R.Kadiyali., “Transportation Engineering”, Khanna Book publishing Co (P) Ltd, 2021.
3. Jotin Khisty C and B.Kent Lall, “Transportation Engineering-An Introduction”, Prentice Hall of India Private Limited, 2009.
4. Igor Ivan, Itzhak Benenson, Bin Jiang, Jiri Horak and James Haworth., “Geoinformatics for Intelligent Transportation System”, Springer International Publishing AG, 2015.
5. Barry Boots, Atsuyuki Okabe and Richard Thomas., “Modelling Geographical Systems - Statistical and computational applications”, Kluwer Academic Publishers, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	2	3	3	3	3	3	2		3	2	2	2
2	3	3	3	3	3	3	3	3	3	2	3	3	2	2	2
3	3	3		3	3	3	3	3	3	-	-	-	3	3	3
4	3	3	3	-	2		3	-	-	3	3	3	3	3	3
5	3	3	3	-	3	3	3	-	-	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

GI5016 GEOMATICS FOR HYDROLOGY AND WATER RESOURCES L T P C
3 0 0 3

UNIT I HYDROLOGIC COMPONENTS 9

Hydrologic cycle - Estimation of various components - Clouds: Types of Clouds - rainfall: Types of Rainfall - runoff - evaporation - transpiration - Evapo-transpiration -Interception - Depression storage - Spectral properties of water.

UNIT II SURFACE WATER MODELLING 9

Drainage basin - Delineation and codification of watershed - Morphometric analysis - Hydrological Modelling - Rainfall - runoff modelling - USDA-SCS-CN Method - Urban Hydrology - LiDAR Mapping for Urban area - Impact of Climate change on Hydrological modeling - Water quality mapping and monitoring - Correlation model for pollution detection.

UNIT III RISK AND DAMAGE ASSESSMENT 9

Mapping of snow-covered area - Snow melt runoff - Glacier runoff modelling - Flood forecasting - Flood Risk Zoning - Flood damage assessment - Flood Modelling - Early warning system for Flood mitigation - drought- Types - Assessment of droughts and mitigation - Desertification - Water harvesting methods, Assessments of intervention measures.

UNIT IV GROUNDWATER MODELLING 9

Origin - Classification and properties of aquifer - Ground water potential identification - Surface indicators - Aquifer parameters - Hydrologic budgeting - Different types of Ground water models - Mathematical modelling of groundwater system - Sea water intrusion - Interfacing GIS with groundwater model - Artificial recharge.

UNIT V IRRIGATION AND WATERSHED MANAGEMENT 9

Crop water requirements - Crop Stress: Biophysical Indicators - Irrigation performance assessment - Reservoir Sedimentation Studies - Capacity curve generation - modelling of reservoir siltation - Impact of climate and land use change on drainage basin - Erosion Estimation using Remote sensing - Prioritization of watersheds - watershed modelling for sustainable development.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the challenges faced by the scientific community in the management of water in the past as well as present situations in the face of ever-changing climate and socioeconomic conditions

CO2 Develop knowledge on the previously used scientific methods and environment development with particular reference to the environment status and scope of geospatial technology to address the WRM issues

CO3 Comprehend the current research trends and the remote sensing data sources, products and tools that are of value along with their limitations so as to find solutions to the issue of various phenomena and domain of WRM

CO4 Analyze the complicated and multi-source and layered problems of water resources management with state of the art, tools and techniques for sustained livelihood

CO5 Apply the knowledge in the conceptualization of extraction and implementation of the Geospatial based solutions sets and to interpret them with tools from ancillary sources for dependable policy making

TEXT BOOKS:

1. Gert A. Schultz, Edwin T. Engman, "Remote Sensing in Hydrology and Water Management", Springer, 2011.
2. S. K. Gupta, "Modern Hydrology and Sustainable Water Development", John Wiley & Sons, 2010.
3. K. Ramamohan Reddy, B. Venkateswara Rao, C. Sarala, "Hydrology and Watershed Management with a Focal Theme on Ecosystem Resilience - Rural and Urban Water Requirements", 2014.

REFERENCES:

1. Schultz, G. A. and Engman, E. T., "Remote Sensing in Hydrology and Water Management", Springer, 2000.
2. David Keith Todd , "Groundwater Hydrology", John Wiley & Sons, New York, 2nd Edition, 2005.
3. H. M. Raghunath , "Hydrology- principles, Analysis, Design", New Age International, 2000.
4. L. Asawa, "Irrigation and Water Resources Engineering", New Age International, 2008.
5. Andrew Skidmore, "Environmental Modelling with GIS and Remote Sensing", 2017.
6. Dorota Swiatek, Stefan Ignar, "Modelling of Hydrological Processes in the Narew Catchment", Springer Science & Business Media, 2011.
7. Tim Davie, "Fundamentals Of Hydrology", 3rd edition, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	3	-	-	-	-	-	-	-	3		
2	3	3	3	-	3	-	-	-	-	-	-	-	3	3	
3	3	3	-	3	3	-	-	-	-	-	-	-	3	3	
4	3	3	3		2	-	-	-	-	-	-	-	3	2	3
5	3	3	3	3	3	-	-	-	-	-	-	-	3	2	3
Avg.	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

GI5017 GEOMATICS FOR DISASTER AND RISK MITIGATION L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Disaster: Definition and Classification - Hydrological and geological disasters, characteristics crisis and consequences-Role of Government administration, University research organization and NGO's-International disaster assistance-Sharing technology and technical expertise.

UNIT II LONG TERM MITIGATION MEASURES 9

Needs and approach towards prevention-Principles and components of mitigation Disaster legislation and policy - Insurance - Cost effective analysis - Utilization of resources -Training - Education-Public awareness-Roles of media

UNIT III SAFETY RATING OF STRUCTURES 9

Slope stability of Ghat roads -Structural safety of Dams, Bridges, Hospitals, Industrial structures, - Disaster resistant structures-Low cost housing for disaster prone areas-Cyclones helter projects and their implications-Reconstruction after disasters: Issues of practices.

UNIT IV SPACE SCIENCE INPUT IN DISASTER MANAGEMENT 9

Remote sensing in Hazard evaluation- zonation - Risk assessment - Damage assessment- Land use planning and regulation for sustainable development-Communication satellite application-Network-Use of Internet - Warning System-Post disaster review-Case studies.

UNIT V EMERGENCY PLANNING USING SPATIAL AND NON-SPATIAL DATA 9

Information systems management-Spatial and non-spatial data bank creation- Operational emergency management - Vulnerability analysis of infrastructure and settlements - Pre disaster and post disaster planning for relief operations - Potential of GIS application in development planning - Disaster management plan-Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Gain knowledge on various types of disasters and infrastructural facilities available for managing disasters
CO2 Plan long term disaster mitigation measures
CO3 Evaluate the safety of the various social structures
CO4 Use remote sensing data products for disaster management
CO5 Apply GIS concepts in disaster management

TEXT BOOKS:

1. J. P. Singhal., "Disaster Management", Laxmi Publications, 2019 ISBN-10:9380386427, ISBN-13:978-9380386423.
2. Tushar Bhattacharya., "Disaster Science and Management", McGraw Hill India EducationPvtLtd., 2017, ISBN-10:1259007367, ISBN-13:978-1259007361.

REFERENCES:

1. F.G.Bell., "Geological Hazards: Their assessment, avoidance and mitigation", SPON, 2007.
2. George G.Penelis and Andreas J.Kappos., "Earthquake Resistant Concrete Structures ", CRC Press; 1st edition, 1996.
3. "Mitigating Natural Disasters, Phenomena, Effects and Options, A Manual for policy makers and planners", United Nations, 1991.
4. Gupta, Anil.K, Sreeja S, Nair, Bemmerlein-Lux, Florian, Chatterji, Sandhya., "Disaster Management and Risk reduction: Role of Environmental Knowledge", Narosa Publishing House, 2013.
5. Kapur Anu, "Vulnerable India: A Geographical study of Disasters", IIAS and sage Publishers, 2010.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	-	-	-	3	3	3	3	2	-	3	-	2	2
2	-	3	-	-	-	3	3	3	3	2	3	3	-	2	2
3	3	3	-	3	-	3	3	3	3	-	-	-	-	3	3
4	3	3	3	3	3	-	3	-	-	3	3	3	3	3	3
5	3	3	3	-	3	3	3	-	-	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

GI5071 GEOMATICS FOR AGRICULTURE AND FORESTRY L T P C
3 0 0 3

UNIT I CROP INVENTORY AND REMOTE SENSING 9

Introduction - Leaf optical properties - Identification of crops and crop inventorying - crop acreage estimation - Vegetation indices - Yield estimation - Crop production forecasting through digital analysis - Microwave and hyper spectral sensing for crop inventory - Crop monitoring and condition assessment- Case studies.

UNIT II REMOTE SENSING FOR SOIL 9

Introduction - Soil survey, types of soil surveys - Soil genesis and soil classification - Soil taxonomy - Soil reflectance properties - Soil mapping using remote sensing - Problem soils - Saline, alkali soil characteristics - Mapping of saline alkaline soils-soil erosion and sedimentation - Assessment of soil erosion - Estimation of reservoir capacity.

UNIT III LAND EVALUATION AND MANAGEMENT 9

Introduction - Land use/Land cover definition - Land use/ Land cover classification - Concepts and approaches of land evaluation - Change dynamics - Land capability assessments - Decision support system for land use planning - Optimum land use planning for sustainable agriculture.

UNIT IV DAMAGE ASSESSMENT 9

Introduction - Damage by pests and diseases - Crop loss assessment by floods - Flood hazard zone mapping- Remote sensing capabilities and contributions for drought management - Land degradation due to waterlogging and salinity - Crop stress - Reflectance properties of stressed crops - Identification of crop stress - Agricultural insurance in India - CCIS, ECIS, FIIS and NAIS.

UNIT V FOREST MANAGEMENT 9

Introduction - forest taxonomy - Inventory of forests-forest type and density mapping - Biomass assessment - Timber volume estimation - Factors for forest degradation - Mapping degraded forests deforestation and afforestation - Forest fire mapping and damage assessment - species mapping - sustainable development of forests.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Characterize the crops using Remote Sensing tools

CO2 The concepts of soil mapping through remote sensing
CO3 The evaluation of land capability for better land use planning
CO4 Acquire Knowledge in damage assessment using remote sensing
CO5 Understand the forest management using remote sensing

TEXT BOOKS:

1. "Applications of Remote Sensing in Agriculture", Elsevier Science, 2013.
2. Mutlu Ozdogan, Yang Yang., "Remote Sensing of Agricultural crops & Vegetation", Excelic press, 2020.
3. Steve E. Franklin., "Remote Sensing for Sustainable Forest Management", CRC Press, 2001.
4. Srinivas,M.G., "Remote Sensing Applications", Narosa Publishing House, 2001.
5. Andrew Rencz., "Manual of Remote Sensing. Vol.3. Edn.3. Remote Sensing for the Earth Sciences, American Society for photogrammetry and Remote sensing", John Wiley& Sons, 1999.

REFERENCES:

1. Jensen,J.R., "Remote Sensing of the Environment -An Earth Resource Perspective". Pearson Education India; 2nd edition , 2013.
2. Mahesh Gaur, C.B. Pandey & R.K. Goyal., "Remote Sensing in Natural Resources Monitoring and Management", Scientific Publishers, 2016.
3. Agarwal,C.S. and P.K.Garg, "Remote Sensing in Natural Resources Monitoring and Management", WheelerPublishing, 2000.
4. Narayan,L.R.A., "Remote Sensing and its Applications", Universities Press (India) Ltd., , 2001.
5. A.K.Singh &U.K. Chopra., "Geoinformatics Applications in Agriculture", New India Publishing Company, 2007.
6. Peter James Eredics., "Mapping Forestry", ESRI Press, 2010.
7. Nicholas Baghdadi, Clement Mallet, Mehrez Zribi., "QGIS & applications in Agriculture and forest", John wiley &Sons, 2018.
8. Ravi Shankar Dwivedi., "Remote Sensing of Soils", Springer, 017.
9. G.P.Obi Reddy, S.K.Singh., "Geospatial Technologies in Land Resource Mapping, Monitoring and Management", Springer International Publishing, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	2	2	-	1	1	-	3	3	2	1
2	3	2	3	2	3	2	2	-	1	1	-	2	3	2	3
3	2	2	2	3	2	2	3	1	1	1	-	2	3	2	1
4	2	2	3	3	3	2	3	2	3	2	-	3	3	2	3
5	2	2	3	2	2	2	2	-	2	1	-	2	3	2	2
Avg.	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**-**	**2**	**3**	**2**	**2**

• 1' = Low; '2' = Medium; '3' = High

GI5018 GEOMATICS FOR OCEAN AND COASTAL APPLICATIONS L T P C
3 0 0 3

UNIT I FUNDAMENTAL OCEANOGRAPHY AND COASTAL PROCESSES 9

Origin and formation of large water bodies - Ocean basins - Oceanic Zones - Ocean Circulations: Global thermohaline, wind driven circulations and currents - Regional Upwelling and eddy development - Waves: structure, characteristics and wave generated currents - Current meters - Tides - Coastal erosional and accretional landforms.

UNIT II SEA WATER CHARACTERISTICS AND MEASUREMENT 9

Heat, Light and sound transmission characteristics - Seawater chemistry - Ocean Biology - Marine food web - Sea water sampling and measurement - NISKIN water sampler and DSRT - CTD profiler-CTD rosette - Bathythermograph - XBT - Sediment samplers: Dredge,GRAB and deep sea coring devices.

UNIT III COASTAL HYDRODYNAMICS AND SENSING SYSTEMS 9

Sea water intrusion - Pollution dispersion - Coastal protection structures - Platforms and sensing systems - Payloads - Past and current operational satellites: NOAA, SeaSTAR, Adeos, ERS, Topex/Poseidon, QikSCAT and sentinel 3 - Indian missions: Oceansat1 and 2, SARAL and SCATSAT.

UNIT IV REMOTE SENSING RETRIEVAL AND MAPPING 9

Ocean color remote sensing - Bio-optical algorithm and SeaDAS processing - Sea surface temperature estimation - Sea surface topography mapping: RADAR altimetry and data processing - Sea level Anomaly - Scatterometry:Sea surface wind retrieval and mapping - Bathymetry - Bathymetric LiDAR.

UNIT V COASTAL MANAGEMENT APPLICATIONS 9

Coastal zone management: Critical issues, LU/LC and wetland mapping - Coastal Regulation Zones- Potential Fishing Zone Mapping - Shoreline Change Analysis - Sea Level Rise Monitoring - Cyclone tracking and damage assessment - Tsunami early warning system and damage assessment - Use of SAR images - Ship detection - Oil spill studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic concepts of Ocean and Coastal processes
CO2 Gain knowledge on physical, chemical and biological characteristics of sea water
CO3 Familiarize about coastal hydro dynamism and operational sensing systems
CO4 Acquire knowledge on retrieval through remote sensing methods
CO5 Analyze the applicability of retrievals for solving critical issues and develop strategic management plan

TEXT BOOKS:

1. Ian.S.Robinson., “Discovering the Ocean from Space: The unique applications of satellite oceanoghraphy”, Springer &Praxis Publishing, 2010.
2. Seelye Martin., “An Introduction to Ocean Remote Sensing”, Cambridge University Press, 2nd edition, 2014.
3. Ian.S.Robinson., “Measuring the Oceans from Space-The principles and methods of satellite Oceanoghraphy”, Springer &Praxis Publishing, 2004.

REFERENCES:

1. Robert Stewart., “Introduction to Physical Oceanography”, University Press of Florida, 2009.
2. Motoyoshi Okeda and Frederic W.Dobson., “Oceanographic applications of Remote Sensing”, CRC Press, 1995
3. Vasilis D. Valavanis., “Geographical Information System in oceanography & Fisheries”, Taylor & Francis London &NewYork, 1st edition 2007.
4. David Halpem., “Satellites, Oceanography and Society”, Elsevier Science, 2012.
5. Alasdair J.Edward, “Remote Sensing Handbook for Tropical Coastal Management”, UNESCO publishing, 2000.
6. Karsten Mangor, Nils K. Drønen, Kasper H. Kærgaard, Sten E. Kristensen., “Shoreline Management Guidelines”, Publisher: Horsholm, DHI Water & Environment, Denmark, 4th edition, 2017

7. L.S.Robinson. “Satellite Oceanography: An introduction for Oceanographers and Remote-Sensing Scientists”, John Wiley and Praxis Publishing, 1995.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	-	-	3	-	-	-	-	-	-	3	3
2	3	2	2	3	2	-	-	3	3	3	2	2	-	-	2
3	2		3	2	3	3	3	3	2	3	3	3	3	3	3
4	3	3	2	3	3	2	3	2	3	3	3	2	3	3	-
5		3	3	3	3	3	3	3	3		3	3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

VERTICAL V: TRANSPORTATION INFRASTRUCTURE

CE5011 TRAFFIC ENGINEERING AND MANAGEMENT L T P C
3 0 0 3

UNIT I TRAFFIC CHARACTERISTICS 8

Traffic characteristics: Human, vehicular, and Road Characteristics- characteristics of traffic flow - uninterrupted traffic flow -interrupted traffic flow, Fundamentals of Traffic Flow, Urban Traffic problems in India.

UNIT II TRAFFIC SURVEYS 9

Traffic Surveys - Speed, journey time and delay surveys - Vehicle Volume Survey - Methods and interpretation - Origin Destination Survey - Methods and presentation - Parking Survey - Methods, interpretation and presentation - Statistical applications in traffic studies and traffic forecasting - Capacity and Level of Service

UNIT III DESIGN AND CONTROL 10

Channelization -At-grade Intersections - uncontrolled, Rotary and Signalised intersections, signal coordination - basics & types, Grade Separation - methods-merits and demerits

UNIT IV ROAD SAFETY 8

Traffic signs and road markings, Road accidents - Causes, Significance of accident data, Condition and collision diagrams - Statistical Interpretation and Analysis of accident Data, identification of blackspots- Safety countermeasures, Accident prevention, accident cost, Road Safety Audit - Overview, stages of road safety audit

UNIT V TRAFFIC MANAGEMENT 10

Traffic System Management: Regulatory Techniques- one-way street, Reversible Street, Reversible lane, turning movement restrictions, closing streets, Bus Priority Techniques - Priority manoeuvres - With-flow bus lane and contra-flow bus lane; Self- Enforcing Techniques- Demand Management Techniques (TDM) Road pricing, parking control, Tolls, Staggering of office/educational institution hours, work from home - Introduction to Intelligent Transportation Systems (ITS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the principles and standards adopted in Planning and Design of Traffic system

CO2 Apply the knowledge of science and engineering fundamentals in conducting traffic surveys and analyze the problems

CO3 Designing various types of control and regulatory measures to meet an efficient traffic network

CO4 Select appropriate methods to ensure the safety of the road users and analyze the environmental issues related to traffic network

CO5 Understand various traffic management measures in addressing the demand, pricing and ITS applications

TEXTBOOKS:

1. Kadiyali. L.R., Traffic Engineering and Transport Planning, Khanna Publishers, Delhi, 2019.
2. Khanna .K and Justo C.E.G. and Veeraragavan, A Highway Engineering, Nem Chand Bros., Roorkee, Revised 10th Edition, 2014.
3. Srinivasa Kumar, “Introduction to Traffic Engineering”, Universities Press, 2018

REFERENCES:

1. Partha Chakroborty and Animesh Das Principles of Transportation Engineering, PHI Learning Pvt. Ltd., 2011.
2. Papacosta.P.S and Prevedouros.P.D, “Transportation Engineering and Planning, third edition.
3. Indian Roads Congress (IRC) Specifications: Guidelines and special publications on Traffic Planning and Management.
4. C. Jotin Khisty, Kent Lall, Transportation Engineering: An Introduction, Prentice Hall, 1998.
5. Hobbs. F.D. Traffic Planning and Engineering, University of Brimingham, Peragamon Press Ltd, 1994.
6. Taylor MAP and Young W, Traffic Analysis - New Technology and New Solutions, Hargreen Publishing Company , 1998.
7. Jason C.Yu Transportation Engineering, Introduction to Planning, Design and Operations, Elsevier, 1992.
8. Salter. R.I and Hounsell N.B, Highway Traffic Analysis and design, Macmillan Press Ltd.1996.
9. Roger P.Roess, William R.Mcshane and Elena S.Prassas, Traffic Engineering-Second Edition, Prentice Hall Publishers,, Upper Saddle River, New Jersey 1998.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	1	1	2	1	1	2	2	2	3	2	1
2	2	3	3	3	3	1	1	2	3	2	3	2	3	3	2
3	3	3	3	2	2	2	2	2	2	3	2	2	3	3	2
4	2	2	2	3	2	2	1	2	3	3	3	2	3	3	2
5	3	2	2	3	3	2	2	2	2	2	2	2	2	1	3
Avg	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5044 TRANSPORTATION PLANNING PROCESS L T P C
3 0 0 3

UNIT I TRANSPORTATION PLANNING PROCESS 8

Importance of transportation planning, Integration of Land Use and Transport; Systems Approach to Transport Planning; Four Steps in the Transport Planning Process; Travel Demand Modelling Approach; Traffic Analyses Zones - internal and external; Various Transportation Surveys for the collection of data - methodology, analyses of data and presentation of results.

UNIT II TRIP GENERATION STAGE 9

Definition and importance; Trip Production and Attraction, Types of trips; Factors governing trip generation: population related data, land and building use, socio-economic, Trip generation models: Types, Assumptions made, Multiple Linear Regression, category analysis- merits and de-merits of the model, verification, calibration and validation of the model.

UNIT III TRIP DISTRIBUTION STAGE 10

Definition and objective; Data collection, analyses and presentation of trip matrix table, Desire Line Diagram, Development of Gravity, growth factor methods for Trip Distribution, Calibration of gravity model and its validation.

UNIT IV MODAL SPLIT STAGE 9

Factors influencing mode choice - Household characteristics; Zonal Characteristics; Network characteristics - Modal split: pre distribution or post distribution - Mode wise trip matrix and modal split analyses- Overview of Probit and Logit model

UNIT V TRAFFIC ASSIGNMENT STAGE 9

Meaning and objective; General principles; Assignment Techniques- all-or-nothing assignments, multiple route assignment, capacity restraint, diversion curves, Trip assignment route selection; Mode-wise trip matrices; element of transportation network, nodes and links, speed flow curves, minimum path trees.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the fundamentals of transportation planning process and demand estimation
CO2 Understand the trip generation concepts
CO3 Understand the trip distribution concepts
CO4 Apply the mode choice behaviour and mode split models
CO5 Understand the principles of Traffic Assignment Techniques

TEXTBOOKS:

1. Kadiyali. L.R., Traffic Engineering and Transport Planning, Khanna Publishers, Delhi, 2019.
2. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Prentice Hall of India Pvt. Ltd., 2001.
3. Michael J.Bruton, Introduction to Transportation Planning, Hutchinson, London, 1995.

REFERENCES:

1. John W. Dickey, Metropolitan Transportation Planning, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1990.
2. C. JotinKhisty, Kent Lall, Transportation Engineering: An Introduction, Prentice Hall, 1998.
3. Juan de Dios Ort zar and Luis G. Willumsen, Modelling Transport, John Wiley & Sons 2001.
4. Chennai Comprehensive Traffic Study, Chennai Metropolitan Development Authority, 2007.
5. J D Ortuzar and L G Willumnsen. Modeling Transport. John Wiley and Sons, New York, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	3	3	2	2	2	2	2	2	2	3	2	2
2	2	3	3	2	2	2	2	2	2	2	2	1	2	2	2
3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2
4	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2
5	3	3	2	2	2	2	2	2	2	2	2	1	2	3	2
Avg.	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

• 1' = Low; '2' = Medium; '3' = High

CE5045 URBAN AND REGIONAL PLANNING L T P C
3 0 0 3

UNIT I INTRODUCTION 7

Definition of Human settlement, Urban area, Town, City, Metropolitan City, Megalopolis, Urbanisation, Urbanism, Suburbanisation, Urban sprawl, Peri-urban areas, Central Business District (CBD), Urban Agglomeration, Census definition of urban settlements, Classification of urban areas -Positive and negative impacts of urbanisation, **-** Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

UNIT II PLANNING PROCESS AND THEORIES 10

Principles of Planning -Stages in Planning Process - Goals, Objectives, Delineation of Planning Areas, Draft Plans, Evaluation, Final Plan. Planning Theories - Garden City Concept, Geddesian Triad by Patrick Geddes, Modernism Concept by Le-Corbusier, Radbun Concept, Neighbourhoods, Theories of Ekistics, Bid-rent Theory by William Alonso, Green Belt Concept

UNIT III DEVELOPMENT PLANS, PLAN FORMULATION AND EVALUATION 10

Types of plans - Regional Plan, Master Plan, Structure Plan, Detailed Development Plan, New Town/ Satellite town- Development Plan, urban nodes, Smart City Plan -Scope and Content of Regional Plan (RP), Master Plan (MP), and the Detailed Development Plan (DDP), Methodologies for the preparation of the RP, MP, and the DDP - Case Studies.

UNIT IV PLAN IMPLEMENTATION 10

Planning Standards, Project Formulation and evaluation; Project Report preparation and presentation; Legal, Financial and Institutional constraints - Problems due to multiple laws, rules and institutions; Financing of Urban Development Projects; Urban planning agencies and their functions in the plan formulation and implementation.

UNIT V URBAN AND REGIONAL PLANNING LEGISLATIONS, REGULATIONS AND DESIGNS 8

Town and Country Planning, Local Bodies and Land Acquisition Acts, Development and Building Rules, Site analyses, Layouts and Buildings Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Describe basic issues in urban planning
CO2 Formulate plans for urban and rural development
CO3 Plan and analyse socio economic aspects of urban and rural planning
CO4 Design of urban development projects
CO5 Manage urban development projects

TEXTBOOKS:

1. Goel, S.L Urban Development and Management, Deep and Deep publications, New Delhi 2002.
2. George Chadwick, A Systems view of planning, Pergamon press, Oxford 1978.
3. Singh V.B, Revitalised Urban Administration in India, Kalpaz publication, Delhi, 2001.
4. Edwin S.Mills and Charles M.Becker, Studies in Urban development, A World Bank publication, 1986.

REFERENCES:

1. Tamil Nadu Town and Country Planning Act 1971, and Rules made thereunder, Government of Tamil Nadu, Chennai.
2. Thooyavan, K.R., Human Settlements - A Planning Guide to Beginners, M.A Publications, Chennai, 2005.
3. Chennai City Municipal Corporation Act, 1919 and Tamil Nadu District Municipalities Act, 1920.
4. The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.
5. The Tamil Nadu Combined Development and Building Rules, 2019.
6. Urban & Regional Development Plans Formulation & Implementation (URDPFI) Guidelines, Vol I & II, Jan 2015, Govt of India, Ministry of Urban Development.
7. http://moud.gov.in

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	2	2	1	2	2	3	2	1	3	3	1
2	3	3	3	3	2	1	2	2	3	2	2	2	3	1	2
3	3	2	2	2	1	2	1	2	1	2	2	3	3	2	1
4	2	2	2	3	2	2	2	3	3	1	3	3	2	2	3
5	2	2	2	2	2	2	2	3	3	3	1	2	1	3	2
Avg.	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5012 TRANSPORT AND ENVIRONMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 8

Environmental Inventory, Environmental Assessment, Environmental Impact Assessment (EIA), Environmental Impact of Transportation Projects, Need for EIA, EIA Guidelines for Transportation Project, Historical Development.

UNIT II METHODOLOGIES 8

Elements of EIA - Screening and Scoping - Methods of Impact Analysis - Applications - Appropriate methodology.

UNIT III ENVIRONMENTAL IMPACT, PREDICTION AND ASSESSMENT 10

Prediction and Assessment of Impact of Transportation Project at various stages on water, air, noise, land acquisition and resettlement, Socio economic impact, indigenous people, aesthetics, health and safety, energy studies, IRC guidelines.

UNIT IV ENVIRONMENTAL MITIGATION AND MANAGEMENT PLAN 10

Mitigation of the impact on Natural and Man-made Environment, Health, Water, Land, Noise, Air, Public participation, Environmental Management Plan, Energy Conservation, Methods to reduce Global Warming.

UNIT V EIA CASE STUDIES 9

EIA Case Studies on Highway, Railway - EIA Case Studies on Transit Oriented Development (TOD), Compact Cities, Non- Motorised Transport (NMT)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the environmental impact of transportation projects
CO2 Apply various methods of analyzing environmental impact analysis
CO3 Stage wise assessment and prediction of impact of transportation projects
CO4 Select appropriate mitigation methods and environmental management plan
CO5 Reviewing various case studies on environmental impact assessment of transport projects

TEXTBOOKS:

1. Canter, L.R., Environmental Impact Assessment, McGraw Hill, New Delhi, 1996.
2. Indian Road Congress (IRC), Environmental Impact of Highway Projects, IRC, Delhi, 1998.
3. P. Meenakshi, Elements of Environmental Science and Engineering, Prentice Hall of India, New Delhi, 2006.
4. Thirumurthy A.M., Introduction to Environmental Science and Management, Shroff Publishers, Bombay, 2005.

REFERENCES:

1. John G.Rau and David, C.Hooten, Environmental Impact Analysis Handbook, McGraw Hill Book Company, 1995
2. James H.Banks, Introduction to Transportation Engineering, McGraw Hill Book Company, 2003.
3. World Bank, A Handbook on Roads and Environment, Vol.I and II, Washington DC, 1997
4. Priya Ranjan Trivedi, International Encyclopedia of Ecology and Environment - EIA, Indian Institute of Ecology and Environment, New Delhi, 1998
5. EIA Guidance Manual- Highway- MOEF & Govt of India, 2010
6. Manual on Norms & Standards for Environmental Clearance of large construction projects, MOEF & Govt of India.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	1	2	2	3	1	2	1	2	3	2	2
2	3	3	3	2	2	2	2	2	2	1	2	2	3	2	2
3	2	3	3	2	3	2	2	2	3	2	2	2	3	2	3
4	2	3	2	2	2	2	2	3	3	3	2	2	3	3	2
5	2	2	2	2	2	2	2	3	3	1	3	2	2	2	3
Avg.	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5046 **SMART CITIES** **L T P C**
3 0 0 3

UNIT I INTRODUCTION **6**

Urbanisation, need of focused development, role of Authorities, Smart city, Opportunity and Challenges- Smart infrastructures for city- Smart Cities Mission

UNIT II SMART PHYSICAL INFRASTRUCTURE **12**

Infrastructure development in Smart Cities - Physical Infrastructure, Land Use - Compact/mixed-use development, Transit oriented development (TOD); Smart City Management-Transportation Unified governance structure (UMTA). Smart public transportation, Smart parking, Intelligent traffic

management, Detour management; Low emission vehicles, Electric Mobility - Environmental projects etc.

UNIT III SUSTAINABILITY AND SMART PLANNING 10

Relationship Between Sustainability and Smart planning - Place making project guidelines-Surveillance, Smart Street Lighting, Intelligent Emergency Services, Intelligent Disaster Forecasting and Management, GIS-based Spatial Decision Support Systems, Smart Communication Services

UNIT IV APPLICATION OF TECHNOLOGIES IN SMART CITIES 8

Role of Technologies in Smart Cities - Integrated Command and Control Center (ICCC), Data Analytics, Data driven strategies implementation in smart cities

UNIT V SMART CITIES PROJECT MANAGEMENT 9

Need for project management, Philosophy and concepts; Project phasing and stages; Project organizational structuring: Planning and Scheduling: Project cost analysis; Procurement and Contracting: PPP: Project Monitoring and Evaluation: Risk Management; Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basics of urbanisation and the role of smart cities
CO2 Gain knowledge on implementation of smart physical infrastructure
CO3 Understand the role of smart planning for sustainable development
CO4 Comprehend the knowledge of technologies in smart city planning
CO5 Reviewing the case studies of smart city projects

REFERENCES:

1. P Sharma , “Sustainable Smart cities in India, Challenges and Future Perspectives”, Springer Link, 2017
2. Sameer Sharma,“Smart Cities Unbounded- Ideas and Practice of Smart Cities in India”, Bloomsbury India, 2018.
3. Binti Singh, ManojParmar, “Smart City in India Urban Laboratory, Paradigm or Trajectory? Routledge India,2019
4. https://smartcities.gov.in/guidelines#block-habikon-content
5. https://smartnet.niua.org/learn/library

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	1	3	2	3	1	1	2	2	1	3	3	2
2	3	3	3	2	1	3	3	2	3	1	3	1	3	3	3
3	3	1	3	2	1	1	3	3	2	2	3	2	3	2	3
4	3	2	2	2	3	2	3	2	3	1	3	2	3	2	2
5	2	2	3	3	2	2	2	2	3	3	2	2	2	3	3
Avg	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5047 INTELLIGENT TRANSPORTATION SYSTEMS L T P C
3 0 0 3

UNIT I INTRODUCTION TO ITS 7

Fundamentals of ITS: Definition of ITS, Challenges in ITS Development-Purpose of ITS Deployment- Benefits of ITS- Overview of application of ITS in Transportation Planning

UNIT II DATA COLLECTION THROUGH ITS 9

Sensors & its application in traffic data collection - Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques - vehicle Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, RFID, video data collection, Internet of Things (IOT)

UNIT III ITS IN TRAFFIC MANAGEMENT 10

ITS User Needs and Services and Functional areas -Introduction, Advanced Traffic Management systems (ATMS), Advanced Traveler Information systems (ATIS), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS)- Autonomous Vehicles- Autonomous Intersections

UNIT IV ITS IN TRANSPORTATION PLANNING 10

ITS and safety, ITS and security- Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations - public transportation applications- Weight -in Motion

UNIT V ITS APPLICATION IN LOGISTICS 9

Commercial vehicle operations and intermodal freight-Fleet Management- IT application in freight logistics-E commerce

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the fundamentals of ITS and its benefits
CO2 Gain knowledge on data collection using sensors and its applications
CO3 Acquainted with the knowledge of ITS in Traffic Management
CO4 Application of ITS in Transportation Planning
CO5 Able to gain knowledge on application of ITS in Logistics

TEXT BOOK:

1. R. Srinivasa Kumar, ”Intelligent Transportation Systems”, Universities Press P Ltd, Telangana, 2022.

REFERENCES:

1. Intelligent Transport Systems, Intelligent Transportation Primer, Washington, US,2001.
2. Henry F.Korth, and Abraham Siberschatz, Data Base System Concepts, McGraw Hill,1992.
3. TurbanE.,”Decision Support and Export Systems Management Support Systems", Maxwell Macmillan,1998.
4. Sitausu S. Mittra, "Decision Support Systems-Tools and Techniques", John Wiley, New York,1986.
5. Cycle W.Halsapple and Andrew B.Winston, "Decision Support Systems-Theory and Application", Springer Verlog, New York, 1987
6. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	2	3	2	2	1	1	1	2	2	3	2	2
2	2	2	1	3	3	2	2	2	2	2	3	2	3	2	2
3	2	1	2	2	3	2	1	1	1	2	1	1	3	2	3
4	2	2	1	3	3	2	1	1	1	1	3	2	3	3	2

5	3	2	1	3	3	2	1	2	2	2	3	2	2	2	3
Avg	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**

• 1' = Low; '2' = Medium; '3' = High

VERTICAL VI: ENVIRONMENT

CE5048 CLIMATE CHANGE ADAPTATION AND MITIGATION L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Atmosphere - weather and Climate - climate parameters - Temperature, Rainfall, Humidity, Wind - Global ocean circulation - El Nino and its effect - Carbon cycle

UNIT II ELEMENTS RELATED TO CLIMATE CHANGE 9

Greenhouse gases - Total carbon dioxide emissions by energy sector - industrial, commercial, transportation, residential - Impacts - air quality, hydrology, green space - Causes of global and regional climate change - Changes in patterns of temperature, precipitation and sea level rise - Greenhouse effect

UNIT III IMPACTS OF CLIMATE CHANGE 9

Effects of Climate Changes on living things - health effects, malnutrition, human migration, socioeconomic impacts- tourism, industry and business, vulnerability assessment- infrastructure, population and sector - Agriculture, forestry, human health, coastal areas

UNIT IV MITIGATING CLIMATE CHANGE 9

IPCC Technical Guidelines for Assessing Climate Change Impact and Adaptation -Identifying adaption options - designing and implementing adaption measures - surface albedo environment- reflective roofing and reflective paving - enhancement of evapotranspiration - tree planting programme - green roofing strategies - energy conservation in buildings - energy efficiencies - carbon sequestration.

UNIT V ALTERNATE FUELS AND RENEWABLE ENERGY 9

Energy source - coal, natural gas - wind energy, hydropower, solar energy, nuclear energy, geothermal energy - biofuels - Energy policies for a cool future - Energy Audit.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Have an insight into carbon cycle, physical basis of the natural greenhouse effect, including the meaning of the term radiative forcing, climate change, global warming and measures to adapt and to mitigate the impacts of climate change

CO2 Have an understanding on the growing scientific consensus established through the IPCC as well as the complexities and uncertainties

CO3 Plan climate change mitigation and adaptation projects including the use of alternate fuels and renewable energy

CO4 Gain in-depth knowledge on climate models

CO5 Post process the modeloutputs for climate impact assessment, know about adaptation strategies

TEXTBOOKS:

1. Ruddiman W.F, freeman W.H. and Company, "Earth"s Climate Past and Future", 2001
2. Velma. I. Grover "Global Warming and Climate" Change. Vol I an II. Science Publishers,

2005.
3. Dash Sushil Kumar, “Climate Change - An Indian Perspective”, Cambridge University Press India Pvt. Ltd, 2007

REFERENCES:

1. IPCC Fourth Assessment Report, Cambridge University Press, Cambridge, UK, 2007
2. Thomas E, Lovejoy and Lee Hannah “Climate Change and Biodiversity”, TERI Publishers, 2005
3. Jan C. van Dam, Impacts of “Climate Change and Climate Variability on Hydrological Regimes”, Cambridge University Press, 2003.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	3	-	-	-	-	-	-	-	1	-	2	-	-	-
2	-	-	-	-	-	2	3	-	-	-	-	-	2	-	-
3	2	3	-	2	3	-	-	-	-	-	-	3	-	-	-
4	2	-	2	2	3	-	-	-	3	-	-	-	-	-	-
5	-	3	-	-	3	2	-	-	3	2	3	2	-	-	2
Avg	2	3	2	2	3	2	3	-	3	1	3	2	2	-	2

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5049 AIR POLLUTION CONTROL ENGINEERING L T P C
3 0 0 3

UNIT I GENERAL 9

Atmosphere as a place of disposal of pollutants - Air Pollution - Definition - Air Pollution and Global Climate - Units of measurements of pollutants - Air quality criteria - emission standards - National ambient air quality standards - Air pollution indices - Air quality management in India.

UNIT II SOURCES, CLASSIFICATION AND EFFECTS 9

Sources and classification of air pollutants - Man made - Natural sources - Type of air pollutants - Pollution due to automobiles - Analysis of air pollutants - Chemical, Instrumental and biological methods. Air pollution and its effects on human beings, plants and animals - Economic effects of air pollution - Effect of air pollution on meteorological conditions - Changes on the Meso scale, Micro scale and Macro scale.

UNIT III SAMPLING, METEOROLOGY AND AIR QUALITY MODELLING 9

Sampling and measurement of particulate and gaseous pollutants - Ambient air sampling - Stack sampling. Environmental factors - Meteorology - temperature lapse rate and stability - Adiabatic lapse rate - Wind Rose - Inversion - Wind velocity and turbulence - Plume behavior - Dispersion of air pollutants- Air Quality Modeling.

UNIT IV AIR POLLUTION CONTROL MEASURES 9

Control - Source correction methods - Control equipments - Particulate control methods - Bag house filter - Settling chamber - cyclone separators - inertial devices - Electrostatic precipitator - scrubbers - Control of gaseous emissions - Absorption - Absorption equipments - adsorption and combustion devices (Theory and working of equipments only).

UNIT V NOISE POLLUTION AND ITS CONTROL 9

Sources of noise - Units and Measurements of Noise - Characterization of Noise from Construction, Mining, Transportation and Industrial Activities, Airport Noise - General Control Measures - Effects

of noise pollution - auditory effects, non-auditory effects. Noise Menace- Prevention and Control of Noise Pollution - Control of noise at source, control of transmission, protection of exposed person - Control of other types of Noise Sound Absorbent.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Various types and sources of Air Pollution and its effects
CO2 Methods of source and ambient monitoring and dispersion of pollutants and their modeling
CO3 The principles and design of control of particulate pollutants
CO4 The principles and design of control of Gaseous pollutant
CO5 Sources, effects and control of vehicular, indoor air and noise pollution

TEXTBOOKS:

1. C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2000.
2. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 1993
3. Dr. Y. Anjaneyulu, "Air Pollution and Control Technologies", Allied publishers Pvt. Ltd., 2002.

REFERENCES:

1. Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition, McGraw Hill Inc, New Delhi, 2000.
2. Air Pollution act, India, 1981
3. Peterson and E.Gross Jr., "Hand Book of Noise Measurement", 5th Edition, 1963
4. Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 1986
5. Antony Milne, "Noise Pollution: Impact and Counter Measures", David & Charles PLC, 1979.
6. Kenneth wark, Cecil F.Warner, "Air Pollution its Origin and Control", Harper and Row Publishers, New York, 1981.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	3	2	2	1	-	-	-	-	2	-	-
2	2	-	-	3	-	-	-	-	2	-	-	2	1	-	2
3	2	-	3	-	3	-	-	-	-	1	2	-	2	-	2
4	2	-	3	-	3	-	-	-	-	1	2	-	2	-	2
5	3	3	2	3	2	-	2	-	2	-	-	-	2	-	-
Avg	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**-**	**2**

1' = Low; '2' = Medium; '3' = High

CE5050 ENVIRONMENTAL IMPACT ASSESSMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India - types and limitations of EIA -EIA process screening- scoping - terms of reference in EIA- setting - analysis -mitigation. Cross sectoral issues -public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 9

Matrices - networks - checklists - cost benefit analysis - analysis of alternatives - expert systems in EIA. prediction tools for EIA - mathematical modeling for impact prediction - assessment of impacts - air - water - soil - noise - biological -- cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 9

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review - mitigation and rehabilitation plans - policy and guidelines for planning and monitoring programmes - post project audit - documentation of EIA findings - ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 carry out scoping and screening of developmental projects for environmental and social assessments

CO2 explain different methodologies for environmental impact prediction and assessment

CO3 asses socio-economic investigation of the environment in a project

CO4 plan environmental impact assessments and environmental management plans

CO5 knowledge to prepare environmental impact assessment reports for various projects

REFERENCES:

1. Canter, L.W., "Environmental Impact Assessment", McGraw Hill, New York. 1996
2. Lawrence, D.P., "Environmental Impact Assessment - Practical solutions to recurrent problems", Wiley-Interscience, New Jersey. 2003
3. World Bank -Source book on EIA
4. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff “Risk Assessment and Management Handbook”, McGraw Hill Inc., New York,1996.
6. K. V. Raghavan and A A. Khan, "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	2	3	3	-	-	-	-	2	-	-
2	3	2	3	2	2	-	-	3	-	-	-	1	-	-	2
3	-	2	3	2	2	-	2	3	2	-	-	1	-	-	2
4	-	-	3	-	3	2	-	2	2	1	1	-	-	-	2
5	3	-	-	2	-	-	-	2	-	-	-	-	-	-	-
Avg	3	2	3	2	2	2	2	3	3	2	1	1	2	-	2

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5051 INDUSTRIAL WASTEWATER MANAGEMENT L T P C

3 0 0 3

UNIT I INTRODUCTION 9

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 industrialwastewater - 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 &WASTE MINIMISATION 9

Prevention vis a vis Control of Industrial Pollution - Benefits and Barriers - Waste management Hierarchy - Source reduction techniques - Periodic Waste Minimisation Assessments - Evaluation of Pollution Prevention Options - Cost benefit analysis - Pay-back period - Implementing & Promoting Pollution Prevention Programs in Industries.

UNIT III INDUSTRIAL WASTEWATER TREATMENT 9

Flow and Load Equalisation - Solids Separation - Removal of Fats, Oil & Grease- Neutralisation-Removal of Inorganic Constituents - Precipitation, Heavy metal removal, Nitrogen & Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Electro dialysis & Evaporation -Removal of Organic Constituents - Biological treatment Processes, Chemical Oxidation Processes, Advanced Oxidation processes - Treatability Studies.

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT 9

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 industrialwastewater treatment - Quantification and characteristics of Sludge - Thickening, digestion,conditioning, dewatering and disposal of sludge - Management of ROrejects.

UNIT V CASE STUDIES 9

Industrial manufacturing process description, wastewater characteristics, source reduction optionsand waste treatment flow sheet for Textiles - Tanneries - Pulp and paper - metal finishing - Sugar and Distilleries.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

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

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

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

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

REFERENCES:

1. "Industrial wastewater management, treatment & disposal, Water Environment" Federation Alexandria Virginia, Third Edition, 2008.
2. Lawrance K.Wang, Yung . Tse Hung, Howard H.Lo and Constantine Yapijakis, “handlook of Industrial and Hazardous waste Treatment”, Second Edition, 2004.
3. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw-Hill companies, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	-	-	-	3	-	-	-	-	3	-	-
2	-	2	-	2	-	-	-	-	2	-	-	3	-	-	2
3	-	2	-	-	-	-	-	3	-	3	-	3	-	-	2
4	-	2	-	2	1	3	3	3	3	3	2	-	-	-	-
5	3	3	-	3	-	3	3	3	2	2	-	3	3	-	2
Avg	3	2	-	3	1	3	3	3	2	3	2	3	3	-	2

• 1' = Low; '2' = Medium; '3' = High

CE5052 SOLID AND HAZARDOUS WASTE MANAGEMENT L T P C
3 0 0 3

UNIT I WASTE CLASSIFICATION AND REGULATORY REQUIREMENTS 9

Sources and types of solid and hazardous wastes - need for solid and hazardous waste management - salient features of latest Indian legislations on management and handling of solid wastes, hazardous wastes, biomedical wastes, electronic wastes, construction and demolition wastes, plastics and discarded lead acid batteries - elements of integrated waste management and roles of stakeholders - seven elements and seven step approach to integrated solid waste management planning.

UNIT II WASTE CHARACTERIZATION SOURCE REDUCTION AND RECYCLING 9

Waste sampling and characterization plan - waste generation rates and variation - physical composition, chemical and biological properties - hazardous characteristics - ignitability, corrosivity and TCLP tests -source reduction, segregation and onsite storage of wastes - waste exchange - extended producer responsibility - recycling of plastics, C&D wastes and E wastes.

UNIT III WASTE COLLECTION TRANSPORT AND MATERIAL RECOVERY 9

Door to door collection of segregated solid wastes - analysis of hauled container and stationery container collection systems - compatibility, storage, labeling and handling of hazardous wastes - principles and design of transfer and transport facilities - hazardous waste transport and manifests - mechanical processing and material separation technologies - Size reduction - size separation - density separation - magenetic separation - compaction - principles and design of material recovery facilities - physico chemical treatment of hazardous wastes - solidification and stabilization - case studies on waste collection and material recovery

UNIT IV BIOLOGICAL AND THERMAL PROCESSING OF WASTES 9

Biological and thermos-chemical conversion technologies - composting - biomethanation - incineration - pyrolysis- plasma arc gasification -principles and design of biological and thermal treatment facilities - MSW processes to energy with high-value products and specialty By-products - operation of facilities and environmental controls - treatment of biomedical wastes - case studies and emerging waste processing technologies.

UNIT V WASTE DISPOSAL 9

Sanitary and secure landfills - components and configuration- site selection - liner and cover systems - geo-synthetic clay liners and geo-membranes - design of sanitary landfills and secure landfills-leachate collection, treatment and landfill gas management - landfill construction and operational controls - landfill closure and environmental monitoring - landfill bioreactors - rehabilitation of open dumps and biomining of dumpsites-remediation of contaminated sites- Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the various functional elements of solid and hazardous waste management including the associated legal, health, safety, and cultural issues as well as responsibilities of different stakeholders

CO2 Apply the knowledge of science and engineering fundamentals to characterize different types of solid and hazardous wastes, assess the factors affecting variation and assess performance of waste treatment and disposal systems

CO3 Design of systems and processes to meet specified needs of waste minimization, storage, collection, transport, recycling, processing and disposal.

CO4 Select appropriate methods for processing and disposal of solid and hazardous wastes, taking into account the impact of the solutions in a sustainability context

CO5 Conduct research pertinent to solid and hazardous waste management and communicate effectively to different stakeholders as well as engage in independent lifelong learning

REFERENCES:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2. CPHEEO, “Manual on Municipal Solid waste management,Vol I, II and III, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2016.
3. William A. Worrell, P. Aarne Vesilind, Christian Ludwig, Solid Waste Engineering - A Global erspective, 3rd Edition, Cengage Learning, 2017.
4. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York,2010.
5. John Pitchtel,Waste Management Practices, CRC Press,Taylor and Francis Group,2014.
6. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, Wiley, 2010
7. Cherry P M, Solid and Hazardous Waste Management, CBS publishers and distributors Pvt Ltd, 2018.
8. Rao M.N, Razia Sultana, Sri Harsha Kota, solid and hazardous waste management - Science and Engineering , Butterworth-Heinemann, 2016

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	3	-	-	-	2	2	-	-	-	-	-	3	-	2
2	3	2	-	2	2	-	-	-	2	-	-	-	2	-	2
3	-	-	3	-	-	-	-	-	2	-	-	-	3	-	2
4	-	2	-	-	2	2	2	2	-	-	2	-	3	-	2
5	-	2	-	2	-	-	-	-	-	1	-	1	-	-	2
Avg	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**3**	**-**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5053 ENVIRONMENTAL LEGISLATIONS IN INDIA L T P C
3 0 0 3

UNIT I INTRODUCTION TO ENVIRONMENTAL LEGISLATIONS AND INTERNATIONAL SCENARIO 9

Significance of Environmental Law **-**International Environmental Law **-**Development of International Environmental Law **-**Source and General principals of International Environmental Law **-**General

rights and obligations of States **-**General Issues of the international law related to environmental protection **-**Stockholm Declaration**-**Rio Declaration on Environment and Development**-**Basel Convention on the Control of Trans boundary Movement of Hazardous Wastes and their disposal**-** Convention of Biological Diversity**-**U.N Frame Work Convention on Climate Change**-**Montreal Protocol on Substances that deplete Ozone Layer**-**Kyoto Protocol**.**

UNIT II INDIAN CONSTITUTIONS AND ENVIRONMENTAL PROTECTION 9

Indian Constitution and Environmental Protection -Constitutional provisions concerning Environment Articles 14,15,(2) (b) 19 (e),21,31,32,38,39,42,47, 48-A,49,51,51-A: Indian Environmental Policy 2006 Administrative machinery for pollution control Common Law & Criminal Law Nuisance, Negligence, Strict liability and Absolute liability, Provisions of IPC relating to environmental problems (public nuisance u/s 268 and others (Sections 269,270,277,284,285,286,425 to 440) Section 133 of Cr.P.C.

UNIT III REMEDIES FOR ENVIRONMENTAL POLLUTION 9

Common Law Remedies/Remedies under Law of Tort - Penal Remedies - Indian Penal Code and Code of Criminal Procedure - Remedies under Constitutional Law - Writs - Public Interest Litigation - Public Liability Insurance Act, 1991 - The National Green Tribunal Act 2010

UNIT IV MAJOR INDIAN LEGISLATIONS 9

Water Act (1974) Air Act (1981) Environmental Protection Act (1986) Major Notifications, The Municipal solid Wastes (Management and Handling) Rules 2000-Bio Medical Wastes (Management and Handling) Rules 1998- Hazardous Wastes (Management and Handling Rules 1989- Environment Impact Assessment Notifications- Coastal Regulation Zone Notification- Public Hearing Notifications

UNIT V ENVIRONMENT AND DEVELOPMENT CASE LAWS 9

Meaning and concept of development - Its impact on environment; conflict between environment and development, Concept of Sustainable Development., Polluter Pay Principle, Precautionary Principle, Public Trust Doctrine. Landmark Judgments **-** Olium gas leakage case, Rural Litigation and Entitlement Kendra, Dehradun, (1985) Supp SCC 487) Vellore Citizen Welfare Forum v. Union of India, (1996) 5SCC 647) Ganga Pollution case (1988) I SCC) S. Jagannath v. UOI (1997) SCC867) Vellore Citizens welfare forum case M.C. Mehta V. Kamalnath (1997) I SCC 388)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand origins and sources of environmental laws, and understand how and by whom environmental laws are made and interpreted

CO2 Understand the key principles of, and actors within, environmental laws

CO3 Understand the National Environmental Policy and Various Legislations enacted in line with Policy

CO4 Critically analyze environmental laws within various contexts and to evaluate laws against procedural and substantive criteria.

CO5 Understand and the Legal system operating in India and will be in a position to prepare compliance reports for getting environmental clearance.

REFERENCES:

1. Leelakrishnan P., Environmental Law in India, Butterworths,1998
2. Leelakrishnan P., Environmental Case Book, Lexis Nexis,2000
3. Shanthakumar S. , Environmental Law - An Introduction, Butterworths,2004
4. Shyam Diwan and Armin Rosencranz, Enviromental Law and Policy in India, Oxford, 2001

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

1	2	-	-	-	-	-	2	-	2	1	-	-	3	-	-
2	1	-	-	-	-	1	2	-	2	1	-	-	3	-	-
3	2	-	2	3	-	2	3	3	-	2	-	2	3	-	-
4	2	-	2	-	-	2	3	3	-	1	-	2	-	-	-
5	-	3	2	3	3	2	3	3	-	2	1	2	3	-	2
Avg	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**-**	**1**	**1**	**2**	**3**	**-**	**2**

• 1' = Low; '2' = Medium; '3' = High

VERTICAL VII: WATER RESOURCES

CE5071 HYDROLOGY AND WATER RESOURCES ENGINEERING L T P C
3 0 0 3

UNIT I PRECIPITATION AND ABSTRACTIONS 9

Hydrological cycle - Meteorological measurements - Requirements, types and forms of precipitation - Rain gauges - Spatial analysis of rainfall data using Thiessen and Isohyetal methods - Interception - Evaporation measurements and evaporation suppression - Infiltration-Horton‟s equation - double ring infiltrometer.

UNIT II RUNOFF 9

Watershed, catchment and basin - Catchment characteristics - factors affecting runoff - Run off estimation - Infiltration indices - Strange‟s table and SCS methods – Stage discharge relationships flow measurements - Hydrograph - Unit Hydrograph - Synthetic Unit Hydrograph.

UNIT III FLOOD AND DROUGHT 9

Natural Disasters - Flood Estimation - Frequency analysis - Flood control - Definitions of droughts - Meteorological, hydrological and agricultural droughts - IMD method - NDVI analysis - Drought Prone Area Programme (DPAP).

UNIT IV RESERVOIRS 9

Classification of reservoirs, General principles of design, site selection, spillways, elevation - area - capacity - storage estimation, sedimentation - life of reservoirs - rule curve - Estimation of Erosion/sediment yield using SWAT Model.

UNIT V GROUNDWATER AND MANAGEMENT 9

Source of groundwater - Classification and types - properties of aquifers- governing equations - Flow through layered soil - steady and unsteady flow - artificial recharge - RWH in rural and urban areas - GEC norms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Define the key drivers on water resources, hydrological processes and their integrated behaviour in catchments

CO2 Apply the knowledge of hydrological models to surface water problems including basin characteristics, runoff and Hydrograph

CO3 Explain the concept of hydrological extremes such as Flood and Drought and management strategies

CO4 Describe the importance of spatial analysis of rainfall and design water storage reservoirs

CO5 Apply the concepts of groundwater for water resources management

TEXTBOOKS:

1. Subramanya K., "Engineering Hydrology", McGraw Hill Education (India) Private Limited - Fourth Edition, 2013.
2. Jaya Rami Reddy P., "Hydrology", Laxmi Publications - Third Edition, 2016.

REFERENCES:

1. David K. Todd and Larry W. Mays "Groundwater Hydrology", Wiley India Pvt Ltd, Third Edition, 2011.
2. VenTe Chow, Maidment, David R. Maidment and Lorry W. Mays, L.W. "Applied Hydrology", McGraw Hill Education, First Edition, 2017.
3. Raghunath H.M., "Hydrology: Principles, Analysis, Design, New Age International Private Limited, Fourth Edition, 2022.
4. Bhagu R. Chahar, "Groundwater hydrology", McGraw Hill Education, First Edition, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	2	2	2	-	-	1	2	-	2	2	2	2
2	3	2	3	3	3	3	2	-	2	-	2	2	2	3	2
3	3	3	2	3	2	2	2	-	2	2	3	2	1	2	3
4	3	3	3	3	3	3	2	-	3	-	2	3	3	3	3
5	2	3	3	2	3	3	3	2	2	-	3	3	2	2	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5072 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

UNIT I THE CONCEPT OF IWRM 9

Water as a global issue: Key challenges - Definition of IWRM- Key elements and pillars of IWRM - Principles - Evolution of IWRM - IWRM relevance in water resources management - IWRM in Global, Regional and Local water partnership - Sustainable Development Goals.

UNIT II ECONOMIC AND LEGAL REGULATORY SETTINGS 9

Basic notion of law and governance: Principles of International and National law in the area of water management - Economic view of water issues: economic characteristics of water good and services - Water economic instruments - Current water pricing policy- Scope to relook pricing

UNIT III EMERGING ISSUES IN WATER MANAGEMENT 9

Emerging Issues - Drinking water management in the context of climate change - Flood - Drought - Pollution - Links between water, health and poverty: options to include water management interventions for health - Health protection and promotion in the context of IWRM - Global burden of Diseases

UNIT IV IWRM AND WATER RESOURCES DEVELOPMENT IN INDIA 9

Ecological sustainability --Watershed development and conservation - Ecosystem regeneration - Wastewater reuse - Sustainable livelihood - Rural Development- IWRM and irrigation- Food security-

Water for food production: Water footprint - Virtual water trade for achieving global water and food security.

UNIT V CONCEPTUAL FRAMEWORK OF IWRM 9

Institutional transformation - Bureaucratic reforms - Inclusive development- Capacity building -- Problems and policy issues - Solutions for effective integrated water management - Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the context and principles of IWRM; Compare the conventional and integrated ways of water management.

CO2 Understand the economic and legal aspects of IWRM.

CO3 Analyse the emerging issues due to climate change and make linkages between water, health and poverty.

CO4 Evaluate the impact of integrated water management on watershed, ecology, agriculture and livelihood of people.

CO5 Develop an integrated framework and arrive at effective solutions for water management problems.

TEXTBOOKS:

1. V. Thomas Cech, Principles of water resources: history, development, management and policy, 4th ed. John Wiley and Sons Inc., New York, 2018.
2. P. Mollinga, et al., Integrated Water Resources Management, Water in South AsiaVolume I, Sage Publications, 2006.

REFERENCES:

1. "Integrated Water resources Management Plan", Cap-Net, GWP- IWRM Training module [Online], March 2005. Available: https:// www.gwp.org/ contentassets/ f998a402e3ab49ea891fa49e77fba953/ iwrmp-training-manual-and-operational-guide.pdf
2. Technical Advisory Committee, "Effective Water Governance, Technical Advisory Committee Background paper No: 7", Global water partnership, Stockholm, Sweden [Online],2003. Available:https://www.gwp.org/globalassets/global/toolbox/publications/background-papers/07-effective-water-governance-2003-english.pdf
3. Technical Advisory Committee, "Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4", Global water partnership, Stockholm, Sweden [Online], 2002.
   Available:https://www.gwp.org/globalassets/global/toolbox/publications/background-papers/04-integrated-water-resources-management-2000-english.pdf
4. Technical Advisory Committee, "Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3", Global water partnership, Stockholm, Sweden [Online], 1999. Available: https://www.gwp.org/ globalassets/global/toolbox/publications/background-papers/03-the-dublin-principles-for-water-as-reflected-in-a-comparatice-assessment-of-institutional-and-legal-arrangements-for-iwrm-1999.pdf

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	1	1	2	2	1	2	2	1	3	2	2	1
2	2	2	2	1	1	2	2	2	2	2	2	3	2	2	1
3	3	2	2	2	1	2	3	2	2	2	1	3	2	2	1
4	3	2	2	2	1	2	3	2	3	2	2	3	2	2	2
5	2	3	3	3	1	2	3	2	3	2	2	3	2	3	3
Avg.	**3**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5008 GROUNDWATER ENGINEERING L T P C
3 0 0 3

UNIT I HYDROGEOLOGICAL PARAMETERS 9

Introduction - Water bearing Properties of Rock - Type of aquifers - Aquifer properties - permeability, specific yield, transmissivity and storage coefficient - Methods of Estimation - GEC norms - Steady state flow - Darcy’s Law - Groundwater Velocity -- Dupuit Forchheimer assumption - Steady Radial Flow into a Well

UNIT II WELL HYDRAULICS 9

Introduction to Unsteady state flow - Theis method - Jacob method - Law of Times - Theis Recovery -- Image well theory - Partial penetrations of wells - Well losses - Specific Capacity and Safe yield - Collector well and Infiltration gallery

UNIT III GROUNDWATER MANAGEMENT 9

Need for Management Model - Database for Groundwater Management - Groundwater balance study - Introduction to Mathematical model - Model Conceptualization and development- Initial and Boundary Condition - Calibration - Validation -Prediction - Sensitivity Analysis - Uncertainty

UNIT IV GROUNDWATER QUALITY 9

Ground water chemistry - Origin, movement and quality - Water quality standards - Drinking water - Industrial water - Irrigation water - Groundwater Pollution and legislation - Environmental Regulatory requirements

UNIT V GROUNDWATER CONSERVATION 9

Natural and Artificial recharge- Reclaimed wastewater recharge -Soil aquifer treatment (SAT) - Managed aquifer recharge(MAR) -Seawater Intrusion and Remediation - Ground water Basin management and Conjunctive use - Groundwater Protection zone delineation, Contamination source inventory and remediation schemes

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Describe the various processes of groundwater system basic, types of aquifers, aquifer parameters, movement and its potential for confined and unconfined aquifers

CO2 Apply their knowledge on well hydraulics to estimate the safe yield and groundwater potential.

CO3 Apply their knowledge on concept of groundwater model development and data base management for groundwater management

CO4 Apply the creative and innovative technique onmanagement of conservation of groundwater quality

CO5 Describe the importance of artificial recharge andgroundwater protection zone and groundwater basin management

TEXTBOOKS:

1. Raghunath H.M., "Ground Water Hydrology", New Age International (P) Limited, New Delhi, Fourth Edition, 2021.
2. Todd D.K., "Ground Water Hydrology", John Wiley and Sons, New York,Third Edition, 2004.

REFERENCES:

1. Fitts R Charles, "Groundwater Science". Elsevier, Academic Press, 2002.
2. Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai, 1998.
3. Chahar BR, Groundwater hydrology, McGraw Hill Education (India) Pvt Ltd, New Delhi, 2015.
4. Rastogi A.K., Numerical Groundwater Hydrology, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	1	1	1	2	3	1	1	1	2	2	2	2
2	3	3	3	2	2	2	2	3	2	2	2	2	2	3	2
3	2	2	3	2	3	2	2	2	1	3	3	2	3	3	3
4	2	2	2	1	3	3	2	3	3	3	2	3	3	3	3
5	2	2	2	2	3	3	2	3	3	3	2	3	3	3	3
Avg.	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5054 WATERSHED MANAGEMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Watershed - Definition - concept - Objectives - Land Capability Classification - priority watersheds land resource regions in India.

UNIT II WATERSHED PLANNING 9

Planning principles - collection of data - present land use - Preparation of watershed development plan - Estimation of costs and benefits - Financial plan - selection of implementation agency - Monitoring and evaluation system.

UNIT III WATERSHED MANAGEMENT 9

Participatory Watershed Management - runoff management - Factors affecting runoff - Temporary & Permanent gully control measures - Water conservation practices in irrigated lands - Soil and moisture conservation practices in dry lands.

UNIT IV WATER CONSERVATION PRACTICES 9

In-situ & Ex-situ moisture conservation principle and practices - Afforestation principle - Microcatchment water harvesting- Groundwater recharge - percolation ponds -Water harvesting - Farm pond -Supplemental irrigation-Evaporation suppression-Seepage reduction.

UNIT V WATERSHED DEVELOPMENT PROGRAMMES 9

RVP- HADP - NWDPRA - Other similar projects operated in India - Govt. of India guidelines on watershed development programmes - Watershed based rural development - infrastructure development - Use of Aerial photography and Remote sensing in watershed management-Role of NGOs in watershed development

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Recognize and interpret the concepts of a watershed and describe the land capability classification of watershed management.

CO2 Able to prepare watershed development plan.

CO3 Describe the runoff management concepts, state, design and sketch the soil conservation structures.

CO4 Illustrate the application of water conservation principle and practices.

CO5 Describe the watershed development programme, use of remote sensing in watershed management.

TEXTBOOKS:

1. Ghanashyam Das, “Hydrology and Soil Conservation Engineering”, Prentice Hall of India Private Limited, New Delhi, 2000.
2. Suresh,R. Soil and Water Conservation Engineering, Standard Publishers & Distributors, New Delhi, 2005.

REFERENCES:

1. Tideman,E.M.,“Watershed Management”,Omega Scientific Publishers, New Delhi,1996.
2. Tripathi R.P. and H.P.Singh, Soil erosion and conservation, Willey Eastern Ltd., New Delhi, 2002.
3. Gurmel Singh et al. Manual of soil and water conservation practices. Oxford & IBH publishing Co. New Delhi, 2004.
4. Murthy, V.V.N. Land and water management, Kalyani publishing, New Delhi, 2005.
5. Suresh,R. Land and water management principles, Standard Publishers & Distributors, New Delhi, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	3	2	1	2	2	1	2	2	2	2	2	2
2	3	2	3	2	3	1	3	3	1	3	3	2	2	2	2
3	3	2	3	2	2	1	2	2	2	2	2	3	2	2	3
4	3	2	2	1	2	2	2	3	1	1	2	2	2	2	2
5	2	2	1	2	3	3	2	3	2	1	1	2	2	2	2
Avg	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**	**2**	**2**	**2**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5055 RAINWATER HARVESTING L T P C
3 0 0 3

UNIT I BASICS OF RWH 8

Water and its sources - Need for water conservation - Types of water demand - Conservation Methods - Global and Indian perspectives - National mission and goals towards rainwater harvesting - National water policy - Legislation on rainwater harvesting in India and Tamil Nadu.

UNIT II HYDROLOGY AND GROUND WATER 10

Hydrological cycle - Precipitation - Rainfall measurement - Rain-gauges - Hyetograph - Infiltration - Runoff estimation - Rooftop runoff estimation. Ground water - Aquifer Properties - Darcy law and well hydraulics - Steady flow.

UNIT III METHODS OF RAINWATER HARVESTING 7

Rainwater harvesting potential of an area - Traditional harvesting practices - Rooftop harvesting - Methods of RWH structures - Site selection for rainwater harvesting - Surface runoff Harvesting - Ground water recharge - Artificial recharge.

UNIT IV DESIGN OF RAINWATER HARVESTING STRUCTURES 10

Design Considerations - Components of Rainwater harvesting system - Simple roof water collection system - Design of Storage structure - Design of Recharge structures - Recharge pit - Recharge trench - Recharge well - Gully plug - Contour bund - Percolation tank - Check dam - Recharge shaft - Efficiency of RWH system

UNIT V MANAGEMENT OF RWH AND CASE STUDIES 10

Difficulties in RWH - At catchment level - At household level - Evaluation of RWH systems - Maintenance of RWH structures - Modernisation of RWH system - Case studies on best practice of RWH in urban - Success stories of Contemporary practices of RWH in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the need and importance of water conservation through global and Indian practices of rainwater harvesting

CO2 Understand and apply the concepts of hydrology and groundwater in the estimation of runoff and recharge potentials

CO3 Understand the various types of rainwater harvesting methods and apply it on the field

CO4 Design the various RWH structures to harvest the rainwater in surface and subsurface

CO5 Explain the difficulties of RWH, evaluation methods and maintenance through various case studies.

TEXT BOOKS:

1. H.M Raghunath “Ground Water” 3rd Edition, New Age International 2007.
2. Jayarami Reddy.P, “A Text book of Hydrology” Firewall media Publication, 2005.
3. Ramakrishnan S, “Ground Water”, Scitech Publications (India) Pvt Ltd., 2010.

REFERENCES:

1. Rain water Harvesting Techniques to Augment Ground Water: Ministry of Water Resources Central Ground Water Board Faridabad, 2003.
2. Rainwater Harvesting: Indian Railway Institute of Civil Engineering Pune, October 2015.
3. A Manual on “Rainwater Harvesting and Conservation”: Government of India, Consultancy Service Organization Central Public Works Department, New Delhi.
4. “A Water Harvesting Manual for Urban Areas” issued by Centre for Science and Environment.
5. Empowering Village Communities for A Sustainable Water Future - A Resource Book for Jaldoots, 2019, Prepared by Central Ground Water Board, Dept. of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti, Govt. of India and MARVI - Managing Aquifer Recharge and Sustaining Groundwater Use through Village-level Intervention.

CO-PO & PSO MAPPING

CO	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	1	2	2	2	1	1	1	2	2	2	1
2	3	3	2	2	3	2	1	1	1	1	2	2	2	2	2
3	2	2	2	2	2	2	2	1	1	1	1	2	2	2	2
4	3	3	3	3	3	3	2	2	2	1	3	2	3	3	3
5	2	2	2	2	2	2	2	2	2	1	2	2	3	3	3
Avg.	2	2	2	2	2	2	2	2	1	1	2	2	2	2	2

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5056 WATER RESOURCES AND GLOBAL CLIMATE CHANGE L T P C
3 0 0 3

UNIT I WEATHER AND CLIMATE 10

Weather and Climate - Drivers of Climate change - Components of Global Climate System: Atmosphere, hydrosphere, Lithosphere, cryosphere and biosphere, atmospheric circulation- Planck's Law and Blackbody Radiation - Hadley Circulation and Climate - Global Energy Balance: Greenhouse effect; Hydrological cycle - Trophical climate, Monsoons and their role in global climate change - Ocean circulation.

UNIT II CLIMATE VARIABITLIY AND CHANGE 9

Natural Climate Variability and Change: large scale variability - El Nino, La Nina - ENSO, Teleconnections, Sun-Moon-Earth interaction - Factors Responsible for Anthropogenic Climate Change, Detection and Attribution of Climate Change; Global and Indian Scenarios - IPCC - Scenarios: SRES, RCPs and SSPs.

UNIT III VULNERABILITY ASSESSMENT 7

Need for vulnerability assessment - Conceptualization of Vulnerability - Approaches for assessment - Methods of analyzing vulnerability: econometric method, Indicator method - Types of climate models, History of climate modelling - Climate models: GCM and RCM.

UNIT IV CLIMATE CHANGE ADAPTATION AND MITIGATION 10

Traditional and modern harvesting system - Water-related adaptation to climate change - Agriculture and food security, land use and forestry, Human health, water supply and sanitation, infrastructure and Economy - Adaptation, vulnerability and sustainable development Sector- specific mitigation - Carbon dioxide capture and storage (CCS) , Bio-energy crops, Biomass electricity, Hydropower, Geothermal energy, Energy use in buildings, Land-use change and management, Cropland management, Afforestation and Reforestation.

UNIT V CLIMATE CHANGE IMPACTS ON WATER RESOURCES 9

General Circulation Models - Regional climate models - Case studies on impacts of climate change on river systems, Water resources assessment, water quality, groundwater, irrigation and agriculture.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Define the earth's climate system and the interaction among the subsystems of the earth components

CO2 Illustrate the basics of climate variability and change including the observations and projections

CO3 Explain the approaches and tools for vulnerability assessment.

CO4 Describe the options available for adaptation and mitigation for different sectors.

CO5 Able to assess the climate change impact on river systems, water resources, water quality, groundwater, irrigation and agriculture through case studies

TEXT BOOKS:

1. A. Barrie Pittock, Climate change, The Science, Impacts and Solutions, CSIRO Publishing, 2nd edition, 2009.

REFERENCES:

1. Sangam Shrestha, S. Mukand, Babel and Vishnu Prasad Pandey, Climate Change and Water Resources, CRC Press an imprint of the Taylor & Francis Group, 2014
2. M. John, Wallace and Peter V. Hobbs,Atmospheric Science: An Introductory Survey, Second Edition, Academic Press an imprint of Elsevier, 2006.
3. J. David Neelin, Climate Change and Climate Modeling, University Press, Cambridge, United Kingdom, 2011.
4. K. McGuffie and A. Henderson-Sellers, A Climate Modelling Primer, Third Edition, John Wiley & Sons, Ltd, 2005

5. T. Thomas, Warner, Numerical Weather and Climate Prediction, Cambridge University Press, New York, 2011.
6. Intergovernmental Panel on Climate Change: https://www.ipcc.ch/

CO-PO & PSO MAPPING

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	-	-	-	1	1	-	2	-	1	-	2	-	-	-
2	2	3	-	2	3	2	-	2	-	1	-	2	-	-	-
3	2	2	1	2	3	2	3	2	-	2	-	3	-	-	3
4	3	3	2	2	3	2	2	2	2	2	2	3	3	3	3
5	3	3	3	2	3	3	3	3	2	2	2	3	3	3	3
Avg.	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

VERTICAL VIII: OCEAN ENGINEERING

CE5057 OCEANOGRAPHY L T P C
3 0 0 3

UNIT I PHYSICAL CEANOGRAPHY 9

Introduction to physical oceanography- Origin of Ocean and Ocean basin - Ocean dynamics and upwelling - Heat Budget - Ocean currents and circulation - waves, tides, sea level - Introduction to bottom topography - Coastal landforms - Oceanographic Methods and Instruments

UNIT II CHEMICAL OCEANOGRAPHY 9

Introduction to Chemical Oceanography - Chemical composition of seawater - Concept of Chlorinity & Salinity of sea water - Biogeochemical cycles - Trace metal geochemistry - Organic geochemistry - Tracers in the ocean - Minerals from the Sea

UNIT III BIOLOGICAL OCEANOGRAPHY 9

Photosynthesis – Primary productivity and seasonality - Phytoplankton diversity, diurnal vertical migration - Eutrophication and Harmful algal blooms (HABs) - Zooplankton and Secondary production - Nekton –Food Chain – Food Web –-Marine microbes

UNIT IV GEOLOGICAL OCEANOGRAPHY 9

Structure of Earth's interior - Evolution of the Ocean- Continental drift and plate tectonics- Geochronology - Sea level rise - Marine sediments classification - Marine microfossils.

UNIT V ENVIRONMENTAL OCEANOGRAPHY 9

Definitions and development of the DPSIR framework - Drivers and Pressures - State and Impacts-Drivers - Response(s) and Discussion - Case Studies from Indian Coastline - Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire knowledge on ocean and its dynamic upwelling, topography, landforms, currents and circulation.

CO2 Summarize the chemical components of the oceans, their reactions.

CO3 Assess the relationship between marine organism and their environment.

CO4 Estimate about Continental drift and plate tectonics and different marine sediments.

CO5 Analyze the overall impact of the human activities on the sea, considering the DPSIR framework based on case studies.

TEXT BOOKS

1. David N. Thomas, “Introducing Oceanography”, Dunedin Academic Press Ltd, 2021.
2. Tom S. Garrison, “Oceanography,An Invitation to Marine Science”, 2015.
3. Joseph M. Moran, “Ocean Studies: Introduction to Oceanography”, 2011.
4. John A. Knauss, “Introduction to Physical Oceanography” 3rd Edition, 2016.

REFERENCES:

1. Garrison, Tom S, “Oceanography: an invitation to marine science”, Cengage Learning, 2015.
2. Emerson, Steven R., and Roberta C. Hamme. “Chemical Oceanography”, CambridgeUniversity Press, 2022.
3. Webb, Paul, “Introduction to oceanography”, Roger Williams University, 2021.
4. Beer, Tom, “Environmental oceanography”, CRC Press 2nd Edition, 2017.
5. Knauss, John A, and Newell Garfield, “Introduction to physical oceanography”, Waveland Press 3rd Edition, 2016.

CO-PO & PSO MAPPING

CO	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			2	2	2				3		2	1	3	
2	3			2	2	2		3		3		2	3	3	
3	3			2	2	2		2		2		2	2	3	
4	3			2	2	2		3		2		2	3	3	
5	3	3	3	3	2	2		3		3		2	3	3	3
Avg.	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**		**3**		**2**	**3**	**3**	**3**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5058 OCEAN WAVE DYNAMICS L T P C
3 0 0 3

UNIT I CONSERVATION OF MASS, MOMENTUM AND ENERGY 7

Conservation of mass, momentum, and Energy; Euler Equation – Bernoullis Equation. Potential and Stream function.

UNIT II CLASSIFICATION OF OCEAN WAVES 9

Introduction - wind and waves - Sea and Swell - Introduction to small amplitude wave theory - Mechanics of water waves - Linear (Airy) wave theory: Governing Equation, Boundary Conditions and solutions, Dispersion relation, use of wave tables, Constancy of wave period, Introduction to Tsunami

UNIT III WAVE KINEMATICS 9

Wave celerity, water particle velocities, accelerations, displacements, and pressures. Approximations for deep and shallow water conditions. Integral properties of waves: Mass flux, Energy and energy flux, Group speed.

UNIT IV WAVE TRANSFORMATIONS 8

Shoaling, bottom friction and damping, refraction, reflection and diffraction. Wave Breaking: Type of breaking, Surf similarity parameter. Keulegan-Carpenter number, Ursell Parameter, Scattering parameter, Reynolds Number

UNIT V WAVE ANALYSIS AND WAVE PREDICTION 12

Short term wave analysis- short term wave Height Distribution – Wave period Distribution - Time and Frequency domain Analysis of Wave Records - wave energy spectra –Long term wave analysis – Gumbel Distribution – Weibull Distribution - Statistics analysis of grouped wave data.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the concept of mass, momentum, and wave energy transformations.
CO2 Estimate the different classification of ocean waves
CO3 Explain the wave kinematics along with its properties.
CO4 Understand the principles of wave transformation.
CO5 Analyse and forecast the long term and short term waves.

TEXT BOOK :

1. Boccotti P, “Wave mechanics and wave loads on marine structures”, Butterworth-Heinemann an imprint of Elsevier, 2nd edition, 2015.
2. Dominic Reeve, Andrew Chadwick, Christopher Fleming, “Coastal Engineering: Processes, Theory and Design Practice”, Taylor & Francis Group, CRC Press, 3rd edition, 2018.
3. Dean, R.G. and Dalrymple, R.A., “Water wave mechanics for Engineers and Scientists”, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, Volume 4, 1994.
4. Mani J S, “Coastal Engineering”, PHI Learning Private Limited, 2nd Edition, 2018.

REFERENCES:

1. Pecher, Arthur, and Jens Peter Kofoed, “ Handbook of ocean wave energy”, Springer Nature Volume 7, 2017.
2. Sundar, V. “Ocean wave Mechanics- Applications in Marine Structures”, Edition: 1, 2016.
3. Washington, D.C. : U.S. Army Corps of Engineers, “Coastal engineering manual”, 2002.

CO-PO & PSO MAPPING

CO	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3						2					3	2	3	3
2	3	2				3		3			2	2	2	3	3
3	3	3	2		2	2		2			3	2	3	3	2
4	3	3	3		3	3		3		2	2	3	3	3	2
5	3	3	3	3	3	3		3	2		3	3	3	3	3
Avg.	3	3	3	3	3	3	2	3	2	2	2	2	3	3	2

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5059 SEA SURVEYING AND MONITORING L T P C
3 0 0 3

UNIT I BASICS OF COASTAL AND HYDROGRPAHIC SURVEYING 6

Large scale coastal land surveying – Modern instrumentation – Hydrographic surveys for coastal regions – Fields of applications and uses – Standard specifications and zones of confidence for hydrographic surveys – Nautical charts – Nautical Information Systems

UNIT II PRINCIPLES OF POSITIONING –BASICS 9

Shape of the Earth – Ellipsoid – Local Sphere – Geoid Datum – Types of Datum – Horizontal andVertical Datum – Coordinate Systems – Principles of Cartography – Projections – Different types – Universal Transverse Mercator (UTM) projection.

UNIT III PRINCIPLES OF POSITIONING – INSTRUMENTATION 10

Survey of India –Positioning Methods – Horizontal Control Methods – VerticalControl Methods – Instruments used – Topographic surveying applied to hydrography- Global Positioning systems (GPS) and its types –– Use of modern electronic surveying instruments – Coastline delineation – Coastal and Harbor Surveys

UNIT IV DEPTH DETERMINATION AND SEA FEATURES DETECTION 10

Fundamentals of acoustic wave propagation in ocean waters - Sound velocity computation - Bathymetry Surveying equipment: echosounder, single beam and multibeam sonar, Seismic - sub-bottom profiler, side scan sonar and tracking equipment

UNIT V TIDAL AND CURRENT MEASUREMENTS 10

Principles of Tides and Water Levels - Astronomical Tide Producing Forces - Tidal Characteristics - Non-tidal water level variations - Tide and water level Datum - Principles of Tidal Currents - Measurements and Prediction of Currents and wave measurements.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Acquire knowledge on basics of coastal and hydrographic surveying

CO2 Understand the basics information of shapes of earth, coordinate systems, cartography, Projection and its types.

CO3 Apply the modern electronic instruments for sea and coastal surveying

CO4 Explain the modern instrumentational methods for depth determination and sea features detection .

CO5 Extend the knowledge of Tides and currents

TEXT BOOKS :

1. Ask, T., “Handbook of Marine Surveying”, Sheridan House, 2nd edition, 2007.
2. Ingham, A. E., “Hydrography for the Surveyor and Engineer”, 3rd Edition revised by Abbott V. J., Blackwell Science, 1992.
3. Loweth, R. P. “Manual of Offshore Surveying for Geoscientists and Engineers” Chapman & Hall,1997.
4. Donald B. Thomson, David E. Wells & W. H. Falkenberg , “An Introduction to Hydrographic Surveying”, 1981.
5. J. Paul Guyer, P.E., R.A., “An Introduction to an Overview of Hydrographic Survey Techniques”, Publisher: Guyer Partners 2020.

REFERENCES:

1. Ghilani, C.D. and Wolf, P.R., “Elementary Surveying: An Introduction to Geomatics”, Published by Prentice Hall 13th Edition, 2011.
2. Kennish, M.J, “Practical Handbook of Marine Science”, CRC Press 4th Edition, 2001.
3. Brekhovskikh, L.M. and Lysanov, Y.P, “Fundamentals of Ocean Acoustics”, Springer 3rd edition,2004.
4. de Jong, C. D., Lachapelle, G., Skone, S. & Elema, I. A., Hydrography, Delft University Press, The Netherlands, 2002.
5. International Hydrographic Organisation, “IHO Standards for Hydrographic Surveying“ (S44), IHB Monaco, 1998

CO-PO & PSO MAPPING

CO	PO’s	PSO’s

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3									3		3	1		
2	3									3		2	3	3	
3	3	1	1	3	3	2		2		2		2	2	3	3
4	3	1	1	3	3	3		3					3	3	2
5	3	1	1	3	3	3		3		3		3	3	3	3
Avg.	**3**	**1**	**1**	**3**	**3**	**3**		**3**		**3**		**3**	**3**	**3**	**3**

• 1' = Low; '2' = Medium; '3' = High

CE5060 PORT AND HARBOUR ENGINEERING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Ports and harbors: Classification of ports & harbours – Port and harbor planning and layout – Meteorological, hydrographic, and oceanographic data requirements and measurements for port and harbor design.

UNIT II PORT AND HARBOUR LAYOUT OPERATIONS 9

Port and harbour layout for vessels navigation and cargo handling- port buildings, navigation channels – land reclamation – Dredging -equipment, navigation improvement, pipelines, and cables.

UNIT III PORT FACILITIES 9

Port Development-Planning-Building Facilities, Transit Sheds, Warehouses, Other Port Facilities-services for shipping terminals-inland port facilities planning, Supporting facilities-Railways-Roads-Air communication-Telephones-Fresh water supply-Power supply-Harbour crafts-Internal roads, rail tracks and pavements.

UNIT IV DESIGN OF PORT 9

Types and classification of ports and harbours in India, Natural ports and manmade ports, major ports, minor ports; Design of port infrastructures with regards to cargo handling, cargo storage and integrated transport of goods.

UNIT V DESIGN OF HARBOUR 9

Design harbour Infrastructures - design of break water - shore attached and offshore breakwaters design - harbour basin design, approach channel design, turning basin design, with regards to cargo and passenger terminals

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1 Understand the classification of port and harbor and study about the data requirement and measurements for port and harbour structures.

CO2 Discuss the layout operations for vessel navigation and cargo handling.

CO3 Describe the essential facilities needed in port.

CO4 Explain the design guidelines for port structure.

CO5 Explain the design guidelines for harbour structure.

TEXTBOOKS

1. Bruun, Per. Port engineering: vol. 1. Harbor planning, breakwaters, and marine terminals.1989.
2. A. D. Quinn, "Design and Construction of Port and Marine Structures", McGraw-Hill Book Company, 2nd Edition, 1972.
3. C. A. Thoresen, "Port Design- Guidelines and recommendations", Tapir Publications, Edition 1, 1988. 186

4. J. W. Gaythwaite, Van Nostrand , “Design of Marine Facilities for the Berthing, Mooring and Repair of Vessels” 1990
5. Muir Wood, A.M., and Fleming. C.A., “Coastal Hydraulics Sea and Inland Port Structures”, 1st Edition, Hallstead Press, 2002.

CO-PO & PSO MAPPING

CO	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			2							2		2	2	2
2	3			2											
3	3			3	2				2	3	3		2	2	1
4	3	3	3	2	2	2	2	2	2	2	1	2	3	3	2
5	3	3	3	2	2	2	2	2	2	2	1	2	3	3	2
Avg.	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

• 1’ = Low; ‘2’ = Medium; ‘3’ = High

CE5061 COASTAL ENGINEERING L T P C
3 0 0 3

UNIT I COASTAL ENVIRONMENT 9

Introduction - Coastal morphology and landforms - Beach, coast and shore -wind, waves, Sea and Swell – Tides & currents - Coastal features - Coastal Zonation -Inshore and Offshore Areas - Mean Sea level .

UNIT II WAVES DYNAMICS 9

Basics of waves - Classification - Wave Theory - Physical Characteristics of different types of waves - Linear Wave Theory - Wave celerity - Velocities -Accelerations - Displacements - Wave dynamics in shallow and deep water conditions.

UNIT III NEARSHORE WAVE TRANSFORMATION 9

Introduction to non- linear waves and their properties - Waves in shallow waters : Wave Shoaling, Refraction, Diffraction and Reflection – Wave breaking - Interaction currents and waves- near shore currents- wave run-up and overtopping -

UNIT IV SEDIMENT DYNAMICS AND TRANSPORT 9

Introduction to sediments, Sediment Analysis, types and sizes of sediments, sedimentation processes, sediment Supply & movement - Cross-shore sediment transport - Long shore sediment transport - Shoreline Changes - Shoreline Evolution - Erosion & Accretion.

UNIT V SHORE PROTECTION 9

Design of shore defense structures; Hard Engineering measures - Sea walls, Revetments, Bulkheads, Dikes, Groynes, Breakwaters; Soft Engineering measures — Artificial Reefs, Beach nourishment, Dune regeneration, Salt marsh Creation, Bioshields - Case studies

TOTAL:45 PERIODS

COURSE OUTCOMES:

On successfully completing this course unit, students will be able to:

CO1 Understand the basic concepts of coastal environment.

CO2 Calculate sea state parameters (wave height, wave period, water levels) in shallow and deepwater conditions.

CO3 knowledge on the principles of near-shore wave transformation.
CO4 Analysis the sediment and its transport processes.
CO5 Evaluate measures to protect beaches from erosion due to waves and currents.

TEXTBOOKS:

1. Kamphuis, J.W., Introduction to coastal engineering and management, 2000
2. Dean, R.G. and Dalrymple, R.A., Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1994.
3. Mani J.S, "Coastal Engineering book", PHI Publishing Company, 2nd Edition, 2021.

REFERENCES:

1. Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, Inc., New York, 1978.
2. Sorenson, R.M., Basic Coastal Engineering, A Wiley-Interscience Publication, NewYork, 1978.
3. Coastal Engineering Manual, Vol. I-VI, Coastal Engineering Research Centre, Dept. of the Army,US Army Corps of Engineers, Washington DC,2006.

CO-PO & PSO MAPPING

CO	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1							2			3		3	1		
2	3	3	3					3		3		2	3	3	
3	3	3	2		2	2		2		2		2	2	3	
4	3	3	3		3	3		3				2	3	3	2
5	3	3	3	3	3	3		3		3		3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**		**3**		**2**	**3**	**3**	**2**

• 1' = Low; '2' = Medium; '3' = High

CE5062 OFFSHORE TECHNOLOGY

L	**T**	**P**	**C**
3	**0**	**0**	**3**

UNIT I INTRODUCTION TO OFFSHORE ENVIRONMENT 9

Ocean winds-characterization of wind regime-wind velocity profile, Ocean waves-wave parameters-Introduction to Airy's wave theory and its applications-brief about time and frequency domain analysis, brief introduction about ocean currents-tides, seaquakes, Ice environment, Ice-sea interactions.

UNIT II TYPES OF OFFSHORE STRUCTURES 9

Offshore Structures-need for offshore structures. Types of Offshore Structures -components - materials used-design parameters-suitable environment conditions –construction practices – drawbacks - EIA for Offshore structures.

UNIT III FORCES ON OFFSHORE STRUCTURES 9

Introduction-Permanent loads-operating loads. Environmental forces-wind force-wave force-current force-seaquake force-Ice force. Force due to tides - Marine growth - Use of API RP 2A guidelines.

UNIT IV SUBMARINE PIPELINES AND RISERS 9

Pipeline elements-types of pipelines-laying method-materials. Pipe wall thickness verification. Pipeline stability. Design using DNV 81 code.

UNIT V INTROCUTION TO MARINESEDIMENTS 9

Planning and site exploration - marine sediments classification and its properties-Plasticity-Fall velocity-Influence of shape on fall velocity-Effect of temperature-Effect of Turbulence-Permeability and porosity- Liquefaction of Sands

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the offshore environment and technical terms associated with it.

CO2 Explain the types and choose suitable offshore structures according to environmental conditions

CO3 Investigate various types of forces acting on the offshore structures

CO4 Adapt appropriate codes to design the submarine pipelines

CO5 Discuss about the properties of marine sediments.

TEXT BOOKS

1. Graff, W. J., Introduction to Offshore Structures, Gulf Publ. Co.1981.
2. Dawson, T. H., Offshore Structural Engineering, Prentice Hall, 1983.
3. Reddy, D. V and Arockiasamy, M., Offshore Structures Vol.1 & 2, Kreiger Publ. Co.1991

REFERENCES:

1. B.C Gerwick, Jr. Construction of Marine and Offshore Structures, CRC Press, Florida, 2000.
2. Clauss, G, Lehmann, E &Ostergaard, C, Offshore Structures, Vol. 1 & 2, Springer-Verlag, 1992.
3. Morgan, N., Marine Technology Reference Book, Butterworths, 1990.
4. McClelland, B and Reifel, M. D., Planning and Design of fixed Offshore Platforms, Van Nostrand, 1986.
5. DNV-RP-B101-Corrosion Protection of Floating Protection and Storage Units, 2007.
6. API RP 2A. Planning, Designing and Constructing Fixed Offshore Platforms, API. 2000.

CO-PO & PSO MAPPING

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	1	2	2	1	2	1	1	3	3	2	2
2	3	2	1	1	1	2	2	1	2	1	2	3	3	2	2
3	3	3	3	3	3	3	2	2	2	2	2	2	3	3	3
4	3	3	3	3	3	3	2	2	2	2	2	2	3	3	3
5	3	2	1	1	2	2	2	1	2	1	1	3	3	2	2
Avg.	3	3	3	2	2	2	2	2	2	2	2	2	3	2	2

• 1' = Low; '2' = Medium; '3' = High