

School of Infrastructure

Dual Degree Programme Curriculum and Syllabus

**B. Tech. (Civil Engineering) -
M. Tech. (Environmental Engineering)**

Curriculum for Dual Degree B. Tech.-M.Tech (Civil-Environmental Engineering)

Subject Name	Code	L-T-P	Credit	Contact Hour
SEMESTER - I				
Mathematics - I	MA1L001	3-1-0	4	4
Physics / Chemistry	PH1L001 / CY1L001	3-1-0	4	4
Mechanics / English for Communications or Learning English	ME1L001 / HS1L001 or HS1L002	3-1-0/3-0-2 or 3-1-0	4	4/5 or 4
Electrical Technology / Introduction to Programing and Data Structures	EE1L001 / CS1L001	3-1-0	4	4
Introduction to Manufacturing Processes / Engineering Drawing and Graphics	ME1P001 / CE1P001	0-0-3/1-0-3	2/3	3/4
Physics Laboratory / Chemistry Laboratory	PH1P001 / CY1P001	0-0-3	2	3
Electrical Technology Laboratory / Introduction to Programing and Data Structures Laboratory	EE1P001 / CS1P001	0-0-3	2	3
EAA - 1	ID1T001	0-0-3	1	3
		Total	22/ 23 +1	25/ 27 or 26+3
SEMESTER - II				
Mathematics - II	MA1L002	3-1-0	4	4
Chemistry / Physics	CY1L001 / PH1L001	3-1-0	4	4
English for Communication or Learning English / Mechanics	HS1L001 or HS1L002 / ME1L001	3-0-2 or 3-1-0/3-1-0	4	5 or 4/4
Introduction to Programing and Data Structures / Electrical Technology	CS1L001 / EE1L001	3-1-0	4	4
Chemistry Laboratory / Physics Laboratory	CY1P001 / PH1P001	0-0-3	2	3
Introduction to Programing and Data Structures Laboratory / Electrical Technology Laboratory	CS1P001 / EE1P001	0-0-3	2	3
Engineering Drawing and Graphics / Introduction to Manufacturing Processes	CE1P001 / ME1P001	1-0-3/0-0-3	3/2	4/3
EAA - 2	ID1T002	0-0-3	1	3
		Total	23+1/22	27or 26/ 25 +3
SEMESTER - III				
Introduction to Material Science and Engineering	ID2L001	2-0-0	2	2
Introduction to Bioscience and Technology	ID2L002	2-0-0	2	2
Basic Electronics		3-1-0	4	4
Mathematics - 3 (Probability, Statistics & Stochastic Processes)	MA2L003	3-1-0	4	4
Solid Mechanics	CE2L001	3-1-0	4	4
Surveying	CE2L002	3-0-0	3	3
Basic Electronics Laboratory		0-0-3	2	3
Surveying Practice	CE2P002	0-0-3	2	3
Project Seminar	CE2S001	0-0-0	2	0
		Total	25	25
SEMESTER - IV				
Lateral 1		3-0-0	3/4	3/4
Breadth-1		3-0-0	3/4	3/4
Environmental Science, Technology and Management	ID2L003	2-0-0	2	2
Introduction to Civil Engineering and Construction Materials	CE2L003	3-0-0	3	3
Structural Analysis	CE2L004	3-1-0	4	4
Hydraulics	CE2L005	3-1-0	4	4
Transportation Engineering	CE2L006	3-0-0	3	3
Transportation Engineering Laboratory	CE2P001	0-0-3	2	3
		Total	24/26	25/27

Subject Name	Code	L-T-P	Credit	Contact Hour
SEMESTER - V				
Lateral 2		3-0/1-0	3/4	3/4
Breadth-2		3-0-0	3	3
Design of Reinforced Concrete Structures	CE3L001	3-1-0	4	4
Soil Mechanics	CE3L002	3-1-0	4	4
Water Resources Engineering	CE3L003	3-0-0	3	3
Structural Engineering Laboratory	CE3P001	0-0-3	2	3
Soil Mechanics Laboratory	CE3P002	0-0-3	2	3
Water Resources Engineering Laboratory	CE3P003	0-0-3	2	3
		Total	23/24	26/27
SEMESTER - VI				
Lateral 3			3	3
Breadth - 3			3	3
Design of Steel Structures	CE3L004	3-0-0	3	3
Foundation Engineering	CE3L005	3-0-0	3	3
Water and Wastewater Engineering	CE3L006	3-1-0	4	4
Civil Engineering Drawing and Estimation	CE3P004	0-0-3	2	3
Structural Design and Detailing	CE3P005	0-0-6	4	6
Water and Wastewater Engineering Laboratory	CE3P006	0-0-3	2	3
		Total	24	28
INDUSTRIAL SUMMER TRAINING AFTER 6 th SEMESTER				
SEMESTER - VII				
Breadth - 4		3-0/1-0	3/4	3/4
Water Treatment and Supply	CE6L101	3-1-0	4	4
Wastewater Treatment	CE6L102	3-1-0	4	4
Elective - 1	CE4LXXX/CE6LXXX	3-0-0	3	3
CAD Laboratory	CE4P001	0-0-3	2	3
Industrial Training Defence	CE4T001	0-0-0	2	0
Project - Part 1 (CE)	CE4D001	0-0-0	4	0
Environmental Monitoring Laboratory	CE6P101	0-0-3	2	3
		Total	24/25	17/18
SEMESTER - VIII				
Air Pollution Control	CE6L103	3-1-0	4	4
Environmental Impact Assessment	CE6L104	3-1-0	4	4
Elective - 2	CE4LXXX/CE6LXXX	3-0/1-0	4	4
Elective - 3	CE4LXXX/CE6LXXX	3-1-0	4	3
Advanced Environmental Engineering Laboratory	CE6P102	0-0-3	2	3
Project - Part 2 (CE)	CE4D002	0-0-0	6	0
		Total	23/24	18
SEMESTER - IX				
Elective - 4	CE6LXXX	3-0/1-0	3/4	4
Thesis : Part-I (CE)	CE6D001	0-0-0	12	0
		Total	15/16	4
SEMESTER - X				
Seminar-II	CE6S002	0-0-0	2	0
Environmental Design Sessional	CE6P103	0-0-3	2	2
Thesis : Part-II (CE)	CE6D001	0-0-0	12	0
		Total	16	2
	Grand Total	Total	220/225	

List of Electives (1):

No	Code	Subject Name	L-T-P	Credit
1	CE4L032	Computational Hydraulics	3-0-0	3
2	CE4L033	Water Resources Management	3-0-0	3
3	CE4L034	Hydraulic and Hydrologic Analysis and Design	3-0-0	3
4	CE4L035	Hydropower Engineering	3-0-0	3
5	CE4L042	Sustainable Water and Sanitation System	3-0-0	3
6	CE4L043	Environmental System Management	3-0-0	3
7	CE4L051	River Engineering	3-0-0	3
8	CE4L052	Open Channel Hydraulics	3-0-0	3
9	CE4L054	Design of Hydraulic Structures	3-0-0	3
10	CE4L027	Construction Management	3-0-0	3
11	CE4L029	Advanced Transportation Engineering	3-0-0	3
12	CE4L045	Soil Dynamics	3-0-0	3
13	CE4L046	Advanced Foundation Engineering	3-0-0	3
14	CE4L055	Transportation Planning	3-0-0	3
15	CE4L056	Pavement Design	3-0-0	3
16	CE4L057	Traffic Engineering	3-0-0	3

NB: Any other subjects of same or higher level floated by any other specialisations of School of Infrastructure and/or any other Schools can also be taken as an elective, as suggested by faculty advisor/PG Coordinators

List of Electives (2 to 4):

No	Code	Name	L-T-P	Credit
1	CE6L102	Wastewater Treatment	3-1-0	4
2	CE6L104	Environmental Impact Assessment	3-1-0	4
3	CE6L105	Advanced Water and Wastewater Treatment	3-1-0	4
4	CE6L106	Environmental Economics	3-0-0	3
5	CE6L107	Environmental Hydraulics	3-1-0	4
6	CE6L108	Solid Waste Management	3-1-0	4
7	CE6L109	Industrial Pollution Prevention	3-0-0	3
8	CE6L110	Environmental Chemistry and Microbiology	3-1-0	4
9	CE6L111	Highway Environment and Noise Pollution Control	3-0-0	3
10	CE6L112	Environmental Nanotechnology and Applications	3-1-0	4
11	CE6L113	Water Quality Modeling and Management	3-0-0	3
12	CE6L513	Water Resources Planning and Management	3-1-0	4
13	CE6L514	Design of Pipe Networks	3-1-0	4
14	CE6L515	GIS & Remote Sensing Applications in Civil Engineering	3-0-0	3
15	CE6L516	Non-Point Source Pollution of Water Resources	3-0-0	3
16	CE6L518	Integrated Watershed Management	3-0-0	3
17	CE6L216	Geotechnics of Polluted Sites	3-0-0	3
18	CE6L217	Geotechnics of Waste and Waste Containment	3-0-0	3
19	ES6L104	Groundwater Modeling & Simulation	3-0-0	3
20	MA6L001	Mathematical Methods	3-1-0	4
21	MA6L002	Advanced Techniques in Operation Research	3-1-0	4

NB: Any other subjects of same or higher level floated by any other specialisations of SIF or any other Schools can also be taken as an elective, as suggested by faculty advisor/PG Coordinators

Subject Code: CE1P001	Name: Engineering Drawing	L-T-P: 1-0-3	Credit: 3
Prerequisite: None			
Introduction to IS code of drawing; Conics and Engineering Curves - ellipse, parabola, hyperbola, cycloid, trochoid, involute; Projection of lines - traces, true length; Projection of planes and solids; solid objects - cube, prism, pyramid, cylinder, cone and sphere; Projection on Auxiliary planes; Isometric projection, isometric scale; Section of solids - true shape of section; Introduction to CAD tools - basics; Introduction of Development and Intersection of surfaces.			
Books:			
<ul style="list-style-type: none"> • Bhatt, N.D., Elementary Engineering Drawing, Charotar Publishing House • Gill, P.S., Engineering Drawing & Engg. Graphics, S. K. Kataria & Sons • Lakshminarayan, L.V. & Vaish. R.S., Engineering Graphics, Jain Brothers 			
Subject Code: CE2L001	Name: Solid Mechanics	L-T-P: 3-1-0	Credit: 4
Prerequisite: None			
Stress analysis: forces and moments, theory of stress, principal stresses and stress invariants, compatibility equations, equilibrium equations; Strain analysis: deformation and velocity gradients, Lagrangian and Eulerian description and finite strain, small deformation theory, principal strains and strain invariants, compatibility conditions; Bending of Symmetric and non-symmetric sections; Thick cylinders and pressure vessels; Introduction of theory of elasticity Simple problems (semi-inverse method); Theories of failure; Stress concentration; Fatigue; Creep and relaxation.			
Books:			
<ul style="list-style-type: none"> • Kazioni, S.M.A., Solid Mechanics, Tata McGraw Hill, • Popoo, E.P., Introduction to Mechanics of Solids, Prentice Hill of India • Crandall, S.H., Dahl, N.C., Lardner, T.J. and Sivakumar, M.S., An Introduction to Mechanics of Solids, Tata McGraw Hill • Jindal, U. C., Strength of Materials, Pearson • Timoshenko, Strength of Materials, CBS 			
Subject Code: CE2L002	Name: Surveying	L-T-P: 3-0-0	Credit: 3
Prerequisite: None			
Introduction: Elements of surveying and mapping, types of surveys, Measurement of Distance, Direction and Elevation. Chain Surveying, Compass Surveying, Plane Table Surveying, Levelling and Contouring, Theodolite Surveying, Layout of curves, Tacheometry, Triangulation, Computation of Area and Volume, Total Station, Global Positioning System, Introduction to Remote Sensing and Geographical Information System.			
Books:			
<ul style="list-style-type: none"> • Punmia, B.C., Surveying Vol. I, II and III, Laxmi Publication Pvt. Ltd. • Arora, K. R., Surveying Vol. I, II and III, Standard Book House. • Gopi, S., Sathikumar, R. and Madu, N., Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education India. 			
Subject Code: CE2P002	Name: Surveying Practice	L-T-P: 0-0-3	Credit: 2
Prerequisite: None			
Introduction, Types of Surveys, Chaining, Taping, Corrections, Angle and Direction Measurements, Prismatic compass, Measurement of bearing, Computations of angles from bearings, Theodolite Surveying, Temporary Adjustments, Traversing, Principle of Levelling, Simple and Differential Levelling, Adjustments, Plane table Surveying, Different Methods, Two and Three Point Problems, Minor Surveying Instruments, Setting out Simple Works. Practicals: Chaining, Offsets, Field book entry, Triangulation AND Traversing, Compass Surveying AND Traversing, Plane Table Surveying, Two Point and Three Point Problems, Levelling, Level book entry, Preparation of contour Map, Study of Theodolites and Angle Measurements, Theodolite Traversing, Techeometric Traversing, Use of Distomat / Theomat, Interpretation of Aerial Photographs AND Satellite Imagery. Surveying through Total Station equipment.			
Subject Code: CE2L003	Name: Introduction to Civil	L-T-P: 3-0-0	Credit: 3

	Engineering and Construction Materials		
Prerequisite: None			
Introduction to Civil Engineering; Major Divisions; Civil Engineering Infrastructures; Ethics in Civil Engineering; Properties of construction material and their evaluation; test methods and specifications; Cement – chemical composition, properties such as setting, strength, fineness, hydration; Aggregates – sources, properties, chemical reactivity; Concrete - constituents, proportioning, properties in fresh and hardened state, characteristic strength, quality control, transportation and placing, testing, porosity; Admixtures – chemical, mineral; Steel – properties, types of steel, steel in civil engineering; Bricks – manufacture, properties and classification; masonry bonds; Wood - Structure, defects & preservation; Paints, New materials – Fibre reinforced plastics (FRPs), epoxy-coated bars, Geo-synthetics etc., Construction methodologies and equipment.			
Books:			
<ul style="list-style-type: none"> • Taylor, G.D., Materials of Construction, Prentice Hall • Mehta P.K. and Montiero, P.M.J., Concrete – Material, Microstructure and Properties, Tata Mcgraw Hill • Gambhir, M.L., Concrete Technology, Tata Mcgraw Hill • Neville, A.M. and Brooks, J.J., Concrete Technology, ELBS/Longman • Neville, A.M., Properties of Concrete, 4th Edition, ELBS/Longman • Dayaratnam, P. Brick and Reinforced Brick Structures, Oxford and IBH • Ghose, D.N., Construction Materials, Tata Mcgraw Hill • Relevant IS codes for testing and specifications 			
Subject Code: CE2L004	Name: Structural Analysis	L-T-P: 3-1-0	Credit: 4
Prerequisite: None			
Stability and Determinacy of Structures; Analysis of Statically Determinate Structures; Review of shear force and bending moment diagrams in beams and frames; Plane trusses: Deflection of trusses; Deflection of beams and frames; Influence line diagrams and moving loads; Analysis of Statically Indeterminate Structures; Force and stiffness methods of analysis; Plane trusses by using method of consistent deformations, Beams and frames: Plane trusses by using direct stiffness method; Curved beams, arches and rings;			
Books:			
<ul style="list-style-type: none"> • Wang, C.K., Intermediate Structural Analysis, McGraw Hill • Vazirani, V.N. and Ratwani, M.M., Analysis of Structures Vol-1, Vol-2, Khanna Publishers • Ramamrutham, S. and Narayan, R., Theory of Structures, Dhanpat Rai 			
Subject Code: CE2L005	Name: Hydraulics	L-T-P: 3-1-0	Credit: 4
Prerequisite: None			
Basic properties of water; Determination of hydrostatic forces; Kinematics of flow; Potential flow; Continuity, Energy and Momentum principles; Open channel flow; Uniform and gradually varied flows; Dimensional analysis; Hydraulic similitude and Modelling; Flow in pipes and Pipe networks; Hydraulics machines; Pumps and Turbines.			
Books:			
<ul style="list-style-type: none"> • Subramanya, K., Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill • Kundu, P.K., Cohen, I.M. and Dowling, D.R., Fluid Mechanics, Academic Press, Elsevier • White, F.M., Fluid Mechanics, Tata McGraw Hill • Streeter, V.L., Fluid Mechanics, Tata McGraw Hill 			
Subject Code: CE2L006	Name: Transportation Engineering	L-T-P: 3-0-0	Credit: 3
Prerequisite: None			
Different Modes of Transportation; Highway Development in India; Highway Alignment, Survey and Detailed Project Report; Geometric Design of Highways: cross-sectional elements, horizontal and vertical alignments; Elements of Traffic Engineering; Pavement Materials:			

subgrade soil, aggregates, bituminous binders; Pavement Design: design of flexible and rigid pavements, Elements of Highway Construction: embankment, subgrade, subbase and base courses, bituminous surface courses, concrete pavements, soil stabilization; Drainage; Evaluation and Maintenance of highways.

Books:

- Khanna, S. K. and Justo, C.E.G., Highway Engineering, Nem Chand & Bros
- Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers
- Chakraborty, P. and Das, A., Principles of Transportation Engineering, Prentice Hall of India

Subject Code: CE2P001	Name: Transportation Engineering Laboratory	L-T-P: 0-0-3	Credit: 2
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Prerequisite: None

Tests on Bitumen: Penetration Test, Viscosity Test, Ductility Test, Softening Point Test; Tests on Aggregates: Crushing test, Abrasion Test, Impact Test, Shape Test; CBR test on Soil, Dynamic Cone penetrometer Test, Roughness measurement of road surface, Traffic Studies: Classified Traffic Volume Count, Speed Studies etc.

Books:

- Khanna, S. K. and Justo, C.E.G., Highway Material Testing, Nem Chand & Bros.
- Khanna, S.K, Justo, A and Veeraragavan, A, Highway Materials and Pavement Testing, Nem Chand & Bros.
- Kadiyali, L. R., Traffic Engineering and Transportation Planning, Khanna Publishers

Subject Code: CE3L001	Name: Design of Reinforced Concrete Structures	L-T-P: 3-1-0	Credit: 4
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Prerequisite: None

Introduction to the design of Concrete structures: Structural Systems, Materials, Loadings and Structural Analysis, Working Stress Design, Ultimate Load Design, Limit State Design; Working Stress Design: Beams for Bending Moment and Shear Force; Limit State Design: Beams for Bending Moment, Shear Force, Bond and Torsion. Axially and eccentrically loaded Columns. Beam-Columns for combined compression and flexure. One and two-way Slabs, Structural Components: Isolated and Combined Footings; Lintels, Stair Cases, Retaining Walls.

Books:

- Gambhir, M.L., Design of Reinforced Concrete Structures, PHI Learning
- Varghese, P.C., Limit State Design of Reinforced Concrete, PHI Learning
- Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGraw Hill
- Punmia, B.C., Jain A.K. and Jain A.K., Reinforced Concrete Structures Vol-I and II, Laxmi Publications
- Park, R. and Pauley, T., Reinforced Concrete Structures, Willey International

Subject Code: CE3L002	Name: Soil Mechanics	L-T-P: 3-1-0	Credit: 4
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Prerequisite: None

Introduction, formation of soils, index properties and classification of soils, soil compaction, proctor and modified compaction, field control of compaction, effective stress, stress point and stress path, soil-water-system - surface tension and capillarity, Darcy's law, permeability of soils, methods of determining coefficient of permeability, seepage analysis, flow nets, piping, quick sand condition, compressibility and consolidation of soils, normally and over consolidated soil, time rate of consolidation, determination of coefficient of consolidation, shear strength of soils, direct shear and triaxial tests, Mohr-Coulomb strength criterion, CU, CD and UU tests, pore pressures, Skempton's pore pressure coefficients.

Books:

- Murthy, V.N.S., Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering by Marcel Dekkar, Inc., USA
- Das, B.M., Principles of Geotechnical Engineering, PWS Publishing Company, Boston, USA.
- Terzaghi, K., Ralph B.P. and Mesri, G., Soil Mechanics in Engineering Practice, John Wiely and Sons, Inc.

<ul style="list-style-type: none"> • Muniram, B., Soil Mechanics and Foundations, John Wiely and Sons, Inc. • Lambe, T.W., Whitman, R.V., Soil Mechanics, John Wiely and Sons, Inc. Canada. • Parry, R.H.G., Mohr Circles, Stress Paths and Geotechnics, E & FN SPON publishers. 			
Subject Code: CE3L003	Name: Water Resources Engineering	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: CE2L005: Hydraulics</p> <p>Concepts of hydrologic cycle; Measurement and analysis of precipitation and runoff; Hydrograph analysis; Irrigation requirement of crops; Design of canals; Design and drawing of weirs and barrages; cross drainage works; Classification; analysis; design and drawing of Gravity and Earth dams; Design and drawing of spillways and energy dissipators.</p> <p>Books:</p> <ul style="list-style-type: none"> • Subramanya, K., Engineering Hydrology, Tata McGraw-Hill • Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers • Chow, V.T., Maidment, D.R. and Mays, L.W., Applied Hydrology, Tata McGraw-Hill 			
Subject Code: CE3P001	Name: Structural Engineering Laboratory	L-T-P: 0-0-3	Credit: 2
<p>Prerequisite: None</p> <p>Casting and load-deformation test of reinforced concrete and post tensioned beams; Cement test: Standard consistency, setting times, compressive strength, fineness and soundness; Aggregate Tests: Sieve analysis, Bulking of sand, Aggregate crushing value, Absorption, Unit weights; Tension test of MS, HYSD, HT bars: Yield/Proof stress, Ultimate Strength, Young's modulus, percentage elongation; Compressive strength of bricks and Pre-conditioning; Load deformation testing of steel beam; Concrete mix design and slump test; Demonstration of flow table, compacting factor and V.B. tests; Compressive strength of cubes by Non-Destructive Testing; Dynamics of SDOF, MDOF systems; Indirect tensile strength of cylinders.</p>			
Subject Code: CE3P002	Name: Soil Mechanics Laboratory	L-T-P: 0-0-3	Credit: 2
<p>Prerequisite: None</p> <p>Specific gravity test, sieve analysis, hydrometer analysis, Atterberg's limits tests, Proctor compaction test, relative density of sand, in-situ density test, permeability tests, direct shear test, unconfined compression test, vane shear test, triaxial tests, consolidation test.</p> <p>Books:</p> <ul style="list-style-type: none"> • Lambe, T.W., Soil Testing for Engineers John Wiley & Sons Inc. • Murthy, V.N.S., Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, Marcel Dekkar, Inc., USA. • Robert W.D., Soil Testing Manual: Procedures, Classification Data, and Sampling Practices, McGraw-Hill Professional. 			
Subject Code: CE3P003	Name: Water Resources Engineering Laboratory	L-T-P: 0-0-3	Credit: 2
<p>Prerequisite: CE2L005: Hydraulics</p> <p>Experiments on flow measurements in open channels and pipes; verification of momentum and energy equations; hydraulic jump; measurement of hydrostatic and hydrodynamic forces; flow in open channels; specific energy</p>			
Subject Code: CE3L004	Name: Design of Steel Structures	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Introduction to Steel Structure Design: Structural Systems, Design Loads and Load Combinations, Rolled Sections and Built-up sections; Working Stress Design; Plastic Design; Limit State Design Methods; Design of structural fasteners: rivets, bolts and welds. Simple and Eccentric Connections; Design of tension members; Design of compression members; Design of Built-up column using lacing and battening; Design of flexure members; Design of Beam-Column; Design of Column Bases; Design of Plate Girder and Gantry Girder.</p> <p>Books:</p> <ul style="list-style-type: none"> • Subramanian, N., Design of Steel Structures, Oxford University Press 			

<ul style="list-style-type: none"> • Duggal, S.K., Limit State Design of Steel Structures, McGraw Hill • Ram, K S, Design of Steel Structures, Pearson Education 			
Subject Code: CE3L005	Name: Foundation Engineering	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Introduction, examples of foundation problems, site characterization, soil exploration, site investigation methods, in-situ tests, Bearing capacity: general, local and punching shear failure, effect of size, shape, depth and water table, Settlement of foundations: elastic, consolidation and total settlement, Types of foundation: shallow and deep foundations, isolated, combined, mat etc., contact pressure distribution, basics of design of shallow foundation, deep foundation type, load transfer mechanism in piles, pile capacity, laterally loaded pile, test pile and pile load test, efficiency of pile group, settlement of pile, earth pressure theories: Rankine's theory, Coulomb's theory, Stability analysis of earth retaining structures - gravity, cantilever, counterfort, Slope stability: finite slopes and infinite slopes, Bishop's simplified method, method of slices.</p> <p>Books:</p> <ul style="list-style-type: none"> • Bowles, E., Foundation Analysis and Design by Joseph, McGraw Hill Higher, USA. • Das, B. M., Principles of Foundation Engineering, Cengage Learning. • Das, B. M., Principles of Geotechnical Engineering, Cengage Learning. • Budhu, M., Soil mechanics and foundations, Wiley Publishers, New Delhi. • Murthy, V. N. S., Principles of Soil Mechanics and Foundation Engg, UBSPD. • Khan, I.H., A text book of Geotechnical Engg, Prentice Hall India. • Gopal Ranjan & Rao, A. S. R. Basic and Applied Soil Mechanics, Wiley Eastern Ltd. <p>Bowles, Joseph E. Foundation analysis and design, McGraw-Hill Publishers</p>			
Subject Code: CE3L006	Name: Water and Wastewater Engineering	L-T-P: 3-1-0	Credit: 4
<p>Prerequisite: None</p> <p>General requirement for water supply, population forecasting and water demand, sources, intake, pumping and transportation of water; Physical, chemical and biological characteristics of water and their significance, Water quality criteria, Water borne diseases, Natural purification of water sources. Engineered systems for water treatment: aeration, sedimentation, softening, coagulation, filtration, adsorption, ion exchange, and disinfection. Generation and collection of wastewater, quantities of sanitary wastes and storm water. Design of sewerage system Primary, secondary and tertiary treatment of wastewater; Wastewater disposal standards. Basics of microbiology. Biological wastewater treatment systems: Aerobic processes - activated sludge process and its modifications, trickling filter, RBC, Anaerobic Processes- conventional anaerobic digester, High rate and hybrid anaerobic reactors. Sludge digestion and handling. Disposal of effluent and sludge Design problems on water and wastewater treatment units and sludge digestion.</p> <p>Books:</p> <ul style="list-style-type: none"> • Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., Environmental Engineering, McGraw-Hill International Ed. • McGhee, T. J, Water Supply and Sewerage, McGraw-Hill Inc. • Davis, M. L and Cornwell, D. A, Introduction to Environmental Engineering, McGraw-Hill, Inc. • Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill. • Sawyer, C. N, McCarty, P. L and Parkin, G. F., Chemistry for Environmental Engineers, McGraw- Hill. • APHA, Standard Methods Examination of Water and Wastewater, American Public Health Association, Washington DC. • Manual for Sewer and Sewerage, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India. • Manual for water supply and treatment, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India. 			
Subject Code: CE3P004	Name: Civil Engineering	L-T-P: 0-0-3	Credit: 2

	Drawing and Estimation		
Prerequisite: None			
Building drawing: Components of buildings - Plan, elevation and section of buildings; Hands on Practice using AutoCAD or Solid Works, Estimation: Central line method, short wall - long wall method, units of measurement, Rate analysis, Cost estimation for buildings and other structures.			
Books:			
<ul style="list-style-type: none"> • Malik, R.S. and Meo, G.S. Civil Engineering Drawing, Computech Publications Limited • Dutta, B.N., Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuation, Sangam Books • Chakraborti, M., Estimating, Costing, Specification, Valuation in Civil Engineering, Chakraborti 			
Subject Code: CE3P005	Name: Structural Design and Detailing	L-T-P: 0-0-6	Credit: 4
Prerequisite: CE3L001: Design of Reinforced Concrete Structures			
Detailed Design of Multistoried RC Building and Detailing of RC Slabs, Beams, columns and footings; Design of Industrial Steel Building with Truss Roof and Detailing of Trusses, Gusseted Joints, Eccentric Connections Riveted/Welded, Beam End Connections, Built-up Column; Design and detailing of Special Structures: Pile foundation, Water tank and Retaining wall.			
Subject Code: CE3P006	Name: Water and Wastewater Engineering Laboratory	L-T-P: 0-0-3	Credit: 2
Prerequisite: None			
Physical characteristics of water - Turbidity, Taste, Odor, Colour, Electrical conductivity; Analysis of solids content of water - Dissolved, settleable, suspended, total, volatile, inorganic;; Alkalinity and acidity; Hardness - Total, calcium and magnesium; Analysis of ions - Fluoride, copper, arsenic; Optimum coagulant dose; Break point chlorination; Settling column analysis for sedimentation tank design; BOD and BOD rate constant determination; COD; DO and re-aeration constant determination; Bacteriological quality measurement: MPN, plate count			
Subject Code: CE6L101	Name: Water Treatment and Supply	L-T-P: 3-1-0	Credit: 4
Prerequisite: None			
Water requirements, Types of water demands, Water demand forecasting, Surface water and ground water sources, Water quality and drinking water standards, Water treatment systems, Physico-chemical processes, Sedimentation, Coagulation, Flocculation, Granular media filtration, Disinfection, Water softening, Adsorption and ion exchange processes, Desalination, Membrane filtration, Treatment of specific contaminants: Fluoride, Nitrate and Arsenic, Water supply schemes, Determination of reservoir capacity, Gravitational, pumping and combined water supply schemes, Water-lifting arrangements, Distribution reservoirs and service storage, Pumping and design considerations for pumps, Design and hydraulic analysis of water distribution system, Distribution system components, Aqueducts, Hydraulics of conduits, Appurtenances and valves, water pipes, Storage tanks, Optimization of pipe network systems, Planning of urban and metropolitan water supply project and its implementation			
Books			
<ul style="list-style-type: none"> • Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Ed. • Bhave P. R. and Gupta R., Analysis of Water Distribution Networks, Narosa publishing house, New Delhi. • Qasim S. R., Motley E. M. and Zhu G., Water Works Engineering- Planning, Design and Operation, Prentice Hall. • Central Public Health and Environmental Engineering Organization, Manual on Water Supply and Treatment, 2nd Ed, Ministry of Urban Development, New Delhi December.1999 (Check) • Hammer M. J., Water and Waste water Technology, PHI Learning. • McGhee T. J., Water Supply and Sewerage, McGraw Hill International. • Relevant BIS Codes 			
Subject Code:	Name: Wastewater Treatment	L-T-P: 3-1-0	Credit: 4

CE6L102			
<p>Prerequisite: None</p> <p>Wastewater- Sources, nature and characteristics, Population equivalent, Municipal wastewater collection, Systems of sanitation and water carriage, Estimation of wastewater flows and variation in wastewater flow, Estimation of storm water runoff, Process Flow sheets, Reactor Analysis, Unit operations and processes, Theory and Design of biological treatment processes, Aerobic treatment such as activated sludge process, Extended Aeration, oxidation ditches, Biofilm Processes: trickling filters, biotowers, MBBR and Natural Processes: waste stabilization ponds, aerated lagoon, Anaerobic treatment: upflow anaerobic sludge blanket reactor, Anaerobic Filters, sludge treatment and disposal, Design of a wastewater treatment plant, On Site collection and Disposal, pit latrines, Compositing privy, Septic Tanks and Aqua privy.</p> <p>Books</p> <ul style="list-style-type: none"> • Metcalf & Eddy., Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill. • Central Public Health and Environmental Engineering Organization, Manual on Water Supply and Treatment, 2nd Ed, Ministry of Urban Development, New Delhi December. • Hammer M. J., Water and Waste water Technology, PHI Learning. • McGhee T. J., Water Supply and Sewerage, McGraw Hill International. • Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Ed. • Quasim S. R., Motley E. M. and Zhu G., Water Works Engineering- Planning, Design and Operation, Prentice Hall. <p>Eckenfelder, W. W., Jr. (2000) Industrial Water Pollution Control, 3d ed., McGraw-Hill</p>			
Subject Code: CE6L103	Name: Air Pollution Control	L-T-P: 3-1-0	Credit: 4
<p>Prerequisite: None</p> <p>Air pollution, Sources of air pollution, Types of pollutant, Gases and particulate; Atmospheric sources, sinks, transport; Effects on health and environment; Criteria pollutants, ambient and source standards. Characterization of aerosols, size distributions, Gaseous Pollutants, Control systems, Air quality management, dispersion modeling. Industrial and Vehicular sources of air pollution, Behaviour of pollutants in atmosphere, Emission factors, regulations, control strategies and policies; Monitoring of air pollutants, Particulate and Gaseous Pollutant Control, Control technologies for removal of SO₂, NO_x, VOC, Control technologies for motor vehicles.</p> <p>Books</p> <ul style="list-style-type: none"> • Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Edition. • Nevers N. D., Air Pollution Control Engineering, Mc. Graw Hill International Edition. • Buonicore A.J., and Davis W.T., Air Pollution Engineering Manual, van Nostrand-Reinhold, New York. • Flagan R.C., and Seinfeld J.H., Fundamentals of Air Pollution Engineering, Prentice Hall, New Jersey. • Wark K., Warner C. F. and Davis W., Air Pollution Its Origin and Control, 3rd edition, Harper and Row, New York. • Rao M. N., Air Pollution, Tata McGraw Hill, New Delhi. • Griffin R. D., Principles of Air Quality Management, CRC Press, Boca Raton, USA. 			
Subject Code: CE6L104	Name: Environmental Impact Assessment	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Concept of environmental impact, Introduction to Environmental impact assessment (EIA) - definitions, terminology and concepts, Evolution of EIA in the USA, Key features of the National Environmental Policy Act and its implementation and the Council on Environmental Quality (CEQ) guidelines, Role of the USEPA, Evolution of EIA in India, Sustainable development, Generalised EIA process flow chart, Screening, Initial environmental examination (IEE), Scoping, Public participation. Environment Risk assessment, Pollution prevention and Waste minimization, sustainable development (SD), Life cycle assessment. Global Environmental Issues.</p>			

EIA - Screening and scoping criteria, Rapid and comprehensive EIA, Impact assessment methods, checklists, matrices, quantitative methods, networks, overlay mapping, Impact prediction and evaluation, Legislative and environmental clearance procedures in India and other countries, Siting criteria, CRZ, Public participation, Resettlement and rehabilitation. Practical applications of EIA, EIA methodologies, Baseline data collection, Prediction and assessment of impacts on physical, biological and socio-economic environment, Environmental management plan, Post project monitoring, initial environmental examination (IEE), environmental impact statement (EIS), environmental appraisal, environmental audit (EA), Environmental impact factors and areas of consideration, measurement of environmental impact, organisation, scope and methodologies of EIA, case studies stressing physical aspects of environment, Evolution of EIA, EIA at project, Regional and policy levels, Strategic EIA, EIA process.

Books

- Canter L., Environmental Impact Assessment, McGraw Hill.
- Asolekar S. R. and Gopichandran R. Preventive Environmental Management - An Indian Perspective Foundation Books Pvt. Ltd., New Delhi (the Indian association of Cambridge University Press, UK).
- Rau G.J. and Wooten, C.D., Environmental Impact Analysis Handbook, McGraw Hill.
- Dhameja S. K., Environmental Engineering and Management, S. K. Kataria & Sons
- Anjaneyulu Y. , Environmental impact assessment methodologies, B.S. Publications
- World Bank 'Environmental Assessment Source Book', Environment Dept., Washington D.C.
- Welford R., Corporate Environmental Management, Earthscan Publications Limited, London.
- Sayre D., Inside ISO 14000: Competitive Advantage of Environmental Management, St. Louis Press, Florida.

Subject Code: CE6P101	Name: Environmental Monitoring laboratory	L-T-P: 0-0-3	Credit: 2
Physical and chemical characteristics of water and wastewater, Optimum coagulant dose, Break point Chlorination, DO, BOD and COD, Microbial characteristics of water - total and fecal coliforms, Settling Column Analysis, Ambient air quality Analysis - Determination of SPM, PM ₁₀ , PM _{2.5} , CO, NO _x and SO _x , detection of environmental noise.			
Books			
<ul style="list-style-type: none"> • Standard methods for the examination of water and wastewater, APHA, 20th Edition, Washington, 1998 • Sawyer, C.N. and McCarty, P.L., and Parkin, G.F. Chemistry for Environmental Engineers, 4th Edn. McGraw Hill, New Delhi, 1994. • Garg, S.K., "Environmental Engineering Vol. I & II", Khanna Publishers, New Delhi • Modi, P.N., "Environmental Engineering Vol. I & II", Standard Book House, Delhi-6 			
Subject Code: CE6P102	Name: Advanced Environmental Engineering laboratory	L-T-P: 0-0-3	Credit: 2
Use of analytical instruments such as AAS, GC, LC for gas and micropollutant analysis, heavy metal detection, use of microscope, isolation and analysis of microbes, Tracer Studies for Reactors, Adsorption Kinetics			
Books			
<ul style="list-style-type: none"> • Standard methods for the examination of water and wastewater, APHA, 20th Edition, Washington, 1998 • Sawyer, C.N. and McCarty, P.L., and Parkin, G.F. Chemistry for Environmental Engineers, 4th Edn. McGraw Hill, New Delhi, 1994. 			
Subject Code: CE6P103	Name: Environmental Design Sessional	L-T-P: 0-0-3	Credit: 2
Environmental engineering hydraulic design: design of distribution systems, design of urban sanitary and storm water sewers, design of water and wastewater pumping systems. Design of intake structure, detailed design of water treatment plant, Design of wastewater treatment and disposal systems, use of ANOVA, statistical analysis of case studies, use of software in environmental design.			

Books

- Bhav P R , Optimal Design Of Water Distribution Networks, Narosa publishing house, New Delhi., 2003
- Bhav P R and Gupta R., Analysis of Water Distribution Networks, Narosa publishing house, New Delhi, 2006.
- Montgomery, J.M., Water Treatment Principles and Design, John Wiley and Sons.
- Check for R. Qasim Books for Design of Water Treatment Plant and Wastewater treatment Plant
- Central Public Health and Environmental Engineering Organization, Manual on Water Supply and Treatment, 2nd Ed, Ministry of Urban Development, New Delhi December 1999.- Check its date
- Central Public Health and Environmental Engineering Organization, Manual on Sewerage and Sewage Treatment, 2nd Ed, Ministry of Urban Development, New Delhi, December 2014- Check 2014
- Quasim, S. R., Motley E. M. and Zhu, G., Water Works Engineering- Planning, Design and Operation, Prentice Hall, 2000.

Syllabus of Elective Subjects

Subject Code: CE4L032	Name: Computational Hydraulics	L-T-P: 3-0-0	Credit: 3
<u>Prerequisite: None</u> General numerical methods; Introduction to FEM, FDM and BEM; Perturbation method; Methods of characteristics; Hydroinformatics; Applications to water resources engineering			
Books:			
<ul style="list-style-type: none"> • Michael B. Abbott, Anthony W. Minns, Computational Hydraulics. • Cornelis B. Vreugdenhil, Computational Hydraulics. • Ioana Popescu, Computational Hydraulics. 			
Subject Code: CE4L033	Name: Water Resources Management	L-T-P: 3-0-0	Credit: 3
<u>Prerequisite: None</u> Water resources economics; Water resources conservation techniques; Optimization in water resources engineering; Irrigation management; Reservoir management; Sustainable water resources development; Environmental impact assessment of water resources projects.			
Books:			
<ul style="list-style-type: none"> • Feldman, Dave Water Resources Management. • Nageswara Rao, K., Water Resources Management. • Lenton, Roberto L., Muller, Mike, Integrated Water Resources Management in Practice. 			
Subject Code: CE4L034	Name: Hydraulic and Hydrologic Analysis and Design	L-T-P: 3-0-0	Credit: 3
<u>Prerequisite: None</u> Synthetic design storms & Estimation of peak discharge, Urban storm drainage design, Culvert design, Detention storage design, Flood frequency analysis; Design of water distribution network, Analysis and design of mobile and rigid boundary channels, Tractive force concepts in channel design, Design of canal headworks, distribution works, and cross-drainage works, Design of gravity dams, spillways, and energy dissipators.			
Books:			
<ul style="list-style-type: none"> • Ben C. Yen, Yeou-Koung Tung, Reliability and Uncertainty Analyses in Hydraulic Design: A Report, American Society of Civil Engineers • Bruce E. Larock, Roland W. Jeppson, Gary Z. Watters, Hydraulics of Pipeline Systems, CRC Press • Ghosh, Karunamoy, Analysis and Design Practice of Hydraulic Concrete Structures, PHI 			

Learning Pvt. Ltd			
<ul style="list-style-type: none"> Chow, Ven Te, Maidment, David R. and Mays, Larry W., Applied Hydrology, Tata McGraw-Hill Education 			
Subject Code: CE4L035	Name: Hydropower Engineering	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Power generation through storage (dams) and diversion (barrages); run-of the river schemes with and without pondage; integrated powerhouse with barrage / on diversion channel; pumped storage schemes; tidal power plants; hydroelectric plant layouts for open flow diversion schemes and pressure diversion system or their combinations; underground projects with pressure diversion systems; position of power house (surface, underground or semi-underground); hydropower conveyance structures intakes, conveyance structures and outflow structures; intakes to canals and tunnels (with corresponding de-silting arrangements); intakes for in-stream powerhouses; reservoir type intakes, trash rack and its design; intakes for embankment dams; water conducting systems open channels, fore-bays, tunnels, surge tanks, penstocks, valves and anchor blocks; layout and sections of tunnels; tunnel design basics; construction methods for tunnels; penstock components (bends, reducer, branches, manifolds); turbine foundations and overhead traveling crane frame; underground powerhouse cavern; types of turbines and their selection.</p> <p>Books:</p> <ul style="list-style-type: none"> Subramanya, K., Flow in open channels, Tata McGraw-Hill Education Garg, S. K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers Subramanya, K., Fluid Mechanics and Hydraulic Machines, Tata McGraw-Hill Education Daugherty, Robert Long, Hydraulic Turbines, McGraw-Hill 			
Subject Code: CE4L042	Name: Sustainable Water and Sanitation Systems	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Concept of sustainability in water and waste management, Water Conservation, Rainwater Harvesting: Roof water harvesting, technology, quality, health issues, Groundwater recharge, techniques, case studies, Water tariff, sustainable water management. Decentralised wastewater treatment systems, Reliability and cost effectiveness of wastewater systems, Tertiary treatment, process selection, granular- medium filtration, micro screening, removal of toxic compounds and refractory organics, removal of dissolved inorganic substances, Natural Wastewater Treatment Systems, Natural and constructed wetlands, different types, Mechanisms, performance, design, case studies. Land treatment systems. Wastewater reuse and reclamation. Rural water supply and sanitation, Low-cost sanitation, Dry sanitation methods, Pit latrines, VIP latrines, Aquaprivy, septic tank, Organic solid waste management techniques, Composting/vermicomposting, biogas technology, plasma technology,</p> <p>Books:</p> <ul style="list-style-type: none"> Ahluwalia, P. and Nema, A. K., Water and Wastewater Systems: Source, Treatment, Conveyance and Disposal, S. K. Kataria & Sons. Arceivala, S. J. and Asolekar, S. R., Wastewater Treatment for Pollution Control and Reuse, Tata McGraw Hill. Cites, R. W., Middlebrooks, E. J., and Reed, S. C., Natural Wastewater Treatment Systems, CRC Taylor and Francis. Cairncross, S. and Feachem, R., Environmental Health Engineering in the Tropics, John Wiley & Sons. Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D.), Tata McGraw Hill. 			
Subject Code: CE4L043	Name: Environmental System Management	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Human - environment relationship, normative criteria, descriptive and prescriptive models, limits of growth; Environmental and natural resources economics, pollution control policy, growth in a finite environment; Environmental protection laws; Numerical/mathematical</p>			

modelling of environmental systems, subsystems, and pollutant transport processes; Planning and management of environmental systems: optimization techniques, stochastic modelling, statistical inferences; Large scale systems; Optimal monitoring network design, identification of sources; Risk reliability and uncertainty in environmental systems; Topics in groundwater and surface water quality management.

Books:

- Schnoor, J. L., Environmental Modelling, Wiley-interscience.
- Boubel, R. W., Fox, D. L., Turner, D. B. and Stern, A. C., Fundamentals of Air Pollution, Academic Press, New York.
- Thomann, R. V., and Muller, J. A., Principles of Surface Water Quality Modelling and Control, Harper International Edition.
- Tchobanoglous, G., Schroeder, E. D., Water Quality, Addison – Wesley Publishing Company, Reading, Massachusetts.
- Welford, R., Corporate Environmental Management, Earthscan Publications Limited, London.
- Rosencranz, A., Divan, S. and Noble, M. L., Environmental Law and Policy in India : Cases, Materials and Statutes, Tripathi Pvt. Ltd, Bombay.
- Asolekar, S. R. and Gopichandran, R., Preventive Environmental Management - An Indian Perspective Foundation Books Pvt. Ltd., New Delhi (The Indian Association of Cambridge University Press, UK).

Subject Code: CE4L051

Name: River Engineering

L-T-P: 3-0-0

Credit: 3

Prerequisite: None

River basins; erosion from river catchments and its transportation by rivers; classification of streams, delta, alluvial fans, point bars, etc.; hydraulic geometry and plan form of alluvial rivers; features of gravel bed rivers; bed level changes in streams sedimentation on the upstream and degradation on the downstream of dams and barrages; morphology of some Indian rivers; river flow measurement techniques; stream gauging and analysis of rating curves (hydrometry); dynamics of tidal rivers and estuarine flows; mathematical models for sediment transport and pollutant transport in rivers; introduction to software packages for river flow, sediment and pollutant transport; riverbank erosion mechanisms; direct bank erosion protection methods (use of fascine mattresses; geosynthetics; other [hard] options); indirect bank erosion protection methods (flow deflection using spurs, groynes, etc. and their possible ill effects); foundations for bridges across rivers; river training works (guide bunds) for bridges and barrages.

Books:

- Julien, P. Y., River Mechanics, Cambridge University Press.
- Garg, S. K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers.
- U. S. Army Corps of Engineers, River Hydraulics.

Subject Code: CE4L052

Name: Open Channel Hydraulics

L-T-P: 3-0-0

Credit: 3

Prerequisite: None

Basic concepts; Energy and Momentum equations and their applications; Critical flow, channel control ad transitions; Uniform flow and flow resistance; Sheet flow; Concepts of boundary layer and surface roughness; Theoretical uniform flow equations; Instability of uniform flow; Gradually varied flow, flow profile classification and computation methods; Flow profiles in natural channels; Spatially varied flow; Hydraulic jump; Unsteady flow, continuity equation, dynamic equation, wave propagation; Method of characteristics; Rapidly varied unsteady flow, surges; Dam break problems.

Books:

- Subramanya, K., Flow in Open Channels, Tata McGraw-Hill.
- Chanson, H., Hydraulics of Open Channel Flow, Elsevier.
- Chow, V. T., Open Channel Hydraulics, McGraw Hill.
- French, R., Open Channel Hydraulics, McGraw-Hill.
- Sturm, T.W., Open Channel Hydraulics, Tata McGraw-Hill.

Subject Code: CE4L053	Name: Water Resources Systems	L-T-P: 3-0-0	Credit: 3
<p><u>Prerequisite: None</u> Introduction to systems concept in water resources engineering: its role in planning and management; data acquisition and processing; descriptive and prescriptive models; economics of water resources systems; social, economical, technical and environmental issues; decision making under uncertainty and/or risk; evaluation of project alternatives; application to surface and subsurface water resources systems planning and management.</p> <p>Books:</p> <ul style="list-style-type: none"> • Vedula, S. and Mujumdar, P. P., Water Resources Systems, McGraw-Hill. • Jain, S. K., and Singh, V. P., Water Resources Systems Planning and Management, Elsevier. • Purcell, P., Design of Water Resources Systems, Thomas Telford Publishing. 			
Subject Code: CE4L054	Name: Design of Hydraulic Structures	L-T-P: 3-0-0	Credit: 3
<p><u>Prerequisite: None</u> Concrete dams, force and stress analysis for components like piers, bridges and trash rack and their reinforcement detailing; stress analysis around galleries, adits and shafts and reinforcement provisions; integrated stability analysis of concrete dams considering foundation rock; construction methods for concrete dams. Embankment dams, seepage analysis (finding the phreatic line) for different types of embankment dams; seepage control measures for embankment dams; construction methods for embankment dams. Spillways and energy dissipators design of ogee spillways; calculations for chute spillway profiles; flow characteristics of shaft and syphon spillways; types of energy dissipators, their selection and dimensioning; flow characteristics of radial gates; introduction to relevant BIS codes and guidelines. Barrages - design of barrage structure and canal head regulator; construction methods for barrages. Irrigation structures, Canals, cross drainage works, falls and energy dissipators.</p> <p>Books:</p> <ul style="list-style-type: none"> • Garg, S. K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers. • Ghosh, K., Analysis and Design Practice of Hydraulic Concrete Structures, PHI Learning Private Limited. • Novak, P., Moffat, A. I. B., Nalluri, C., and Narayanan, R. Hydraulic Structures, Taylor & Francis. 			
Subject Code: CE4L027	Name: Construction Management	L-T-P: 3-0-0	Credit: 3
<p><u>Prerequisite: None</u> Construction Management Overview; Construction Industry; Construction Projects Management; Scheduling Techniques for Construction Projects; Construction Estimating; Construction Cost Control; Construction Contracts Administration; Construction Practice</p> <p>Books:</p> <ul style="list-style-type: none"> • Jha, Neeraj Kumar, Construction Project Management, Pearson Education India • Williams, Trefor, Construction Management, Pearson Education India • Chitkara, Krishnan, Construction Project Management Techniques And Practice, Tata McGraw Hill • Purifoy R.L., Construction Planning, equipments and Methods, Mc Graw Hill, Tokyo, Japan. 			
Subject Code: CE4L029	Name: Advanced Transportation Engineering	L-T-P: 3-0-0	Credit: 3
<p><u>Prerequisite: None</u> Airports: introduction; characteristics of aircrafts related to airport design; obstruction clearance criteria; design of airside facilities: runway orientation, length, capacity, configuration and number, taxiway layout, design of fillets, high-speed exit taxiway, apron gate and circulation areas, hanger; design of landside facilities: terminal building functional areas and facilities, centralized and de-centralized concepts, vertical distribution; airport planning and site selection; pavement design; visual aids; demand estimation of air travel, drainage. Railways:- Introduction, classification of routes; railway gauge, coning of wheels and canting of rails, train resistance and</p>			

hauling power; track components: rails, sleepers, fastenings, ballast and formation; track stresses; turnouts and crossings, signals and control systems, welded rails. Elements of water and pipeline transportation. Economic Analysis of Transportation Projects			
Book:			
<ul style="list-style-type: none"> • Horonjeff, Robert, Planning and Design of Airports, McGraw Hill • Chandra, Satish and Agarwal, M.M., Railway Engineering, Oxford University Press India • Garber, NJ and Hoel, LA, Principles of Traffic and Highway Engineering, Cengage Learning 			
Subject Code: CE4L045	Name: Soil Dynamics	L-T-P: 3-0-0	Credit: 3
Prerequisite: None			
Introduction, Fundamental of vibrations, dynamic properties of geomaterials, transient vibrations, analysis of free and forced vibrations using spring dashpot model, single degree of freedom system, multidegrees of freedom system, application of single and multidegree of freedom systems, wave propagation in elastic media, laboratory and field evaluation of soil properties, analysis of earthquake loadings, liquefaction analysis.			
Books:			
<ul style="list-style-type: none"> • Saran, S., Soil Dynamics and Machine Foundations, Galgotia Publications. • Das, B. M. and Ramana, G. V., Principles of Soil Dynamics, CL-Engineering. • Richart, F. E., Woods, R. D., and Hall, J. R., Vibrations of Soils and Foundations, Prentice Hall. • Kramer, S. L., Geotechnical Earthquake Engineering, Prentice Hall. 			
Subject Code: CE4L046	Name: Advanced Foundation Engineering	L-T-P: 3-0-0	Credit: 3
Prerequisite: None			
Bearing capacity of shallow foundations: Prandtl, Terzaghi and Meyerhof s method of analysis, safe and allowable bearing pressures, selection of type and depth of foundations, combined footings, mat foundations including floating raft, settlement calculations, Skempton - Bjerrum modification, and Martin s method, bearing capacity of layered soils, bearing capacity of footings on slopes, Deep foundations: mechanics of load transfer in piles, load carrying capacity, pile load test, lateral loaded piles, design of pile groups including settlement calculations, design of block foundation, well foundations, coffer dams, pier foundations, earth pressure computations on retaining walls and their design, earthquake response of foundations.			
Books:			
<ul style="list-style-type: none"> • Das, B. M., Principles of Foundation Engineering, Cengage Learning. • Budhu, M., Soil Mechanics and Foundations, Wiley Publishers, New Delhi. • Coduto, D. P., Foundation Design: Principles and Practices, Prentice Hill Publishers. • Holts, R. D. and Kovacs, W. D., An Introduction to Geotechnical Engineering, Prentice Hall. • Das, B. M., Shallow Foundations: Bearing Capacity and Settlement, CRC Press. • Tomilson, M. J., Foundation Design and Construction, Pearson Publishers. 			
Subject Code: CE4L055	Name: Transportation Planning	L-T-P: 3-0-0	Credit: 3
Prerequisite: None			
Transportation planning Process, Demand-supply interaction of a transportation system, four-step-travel demand modeling- such as trip generation, trip distribution, modal split and traffic assignment, discussion of case study on travel demand model, land-use transport model, household travel survey, public transportation, traffic forecasting techniques on highway, Demand analysis for air transportation			
Book:			
<ul style="list-style-type: none"> • Kadiyali, L. R., Traffic Engineering and Transport Planning, Khanna Publishers. • Ortuzar, J. D. and Williumsen, L. G., Modeling Transport, John Wiley & Sons Ltd. 			
Subject Code: CE4L056	Name: Pavement Design	L-T-P: 3-0-0	Credit: 3
Prerequisite: None			
Types of Pavement, Pavement Composition, Philosophy of design of flexible and rigid pavements, analysis of pavements using different analytical methods, selection of pavement design input parameters, traffic loading and volume, material characterization, drainage, failure			

criteria, reliability, design of flexible and rigid pavements using different methods, pavement evaluation and overlay design.

Books:

- Huang, Y. H., Pavement Analysis and Design, Pearson Education.
- Yoder, E. J. and Witzak, M. W., Principles of Pavement Design, John Wiley & Sons Ltd.
- Mallick, R. B. and El-Korchi, T., Pavement Engineering: Principles and Practice, CRC Press.

Subject Code: CE4L057	Name: Traffic Engineering	L-T-P: 3-0-0	Credit: 3
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Prerequisite: None

Driver behaviour, visual angle modelling, traffic information and control systems, traffic studies-volume, speed and delay studies, elements of traffic flow theory, Greenshields' model and Greenberg's model, PCU concept, characteristics of uninterrupted traffic, gap acceptance-Raff's method, queuing theory, shock wave, capacity and LOS of Uninterrupted facilities, characteristics of interrupted traffic, IRC method of roundabout design, traffic characteristics at unsignalised intersections, queue discharge characteristics at signalised intersections, Trial Cycle method and Webster's method of signal design, dilemma zone, actuated signal control, signal coordination.

Books:

- Mannering, F. L., Kilareski, W. P. and Washburn, S. S., Principles of Highway Engineering and Traffic Analysis, Wiley India Edition.
- Drew, D. R., Traffic Flow Theory and Control, McGraw-Hill.
- May, A. D. Traffic Flow Fundamentals, Prentice Hall.
- Slinn, M., Guest, P. and Mathews, P., Traffic Engineering Design, Elsevier.
- Roess, R. P., Prassas, E. S., McShane, W. R. Traffic Engineering, Pearson.
- Kadiyali, L. R., Traffic Engineering and Transport Planning, Khanna Publishers.
- Pignaturo, L. J., Traffic Engineering-Theory and Practice, Prentice-Hall, Englewood Cliffs, New Jersey.
- Khanna, S. K. and Justo, C. E. G., Highway Engineering, Nem Chand & Bros, Roorkee.
- Khisty, C. J. and Lal, B. K., Transportation Engineering, Prentice Hall India.
- Papacostas, C. S. and Prevedouros, P. D., Transportation Engineering & Planning, Prentice-Hall.

Subject Code: CE6L105	Name: Advanced Water and Wastewater Treatment	L-T-P: 3-1-0	Credit: 4
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Prerequisite: None

Capabilities and limitations of conventional water and waste water treatment methods, Need for advanced treatment of water and waste water, Advanced water treatment- Iron and manganese removal, colour and odour removal, activated carbon treatment, carbonate balance for corrosion control, ion exchange, electro-dialysis, reverse osmosis and modern methods and fluoride management.

Nitrogen and phosphorus removal methods including biological methods, Methods for the removal of heavy metals, oil and refractory organics, Micro-screening, ultra-filtration, centrifugation and other advanced physical methods- aerobic/anaerobic digestion, anaerobic filtration, novel methods of aeration etc.,

Combined physico-chemical and biological processes, Pure oxygen systems, Filtration for high quality effluents, Multistage treatment systems, Land treatment and other resources recovery systems. Decentralised wastewater treatment systems; Reliability and cost effectiveness of wastewater systems. Natural treatment systems- floating aquatic plant treatment systems, constructed wetlands. Industrial Wastewater management and reuse, removal of industry specific pollutants

Books

- Metcalf & Eddy., Wastewater Engineering- Treatment and Reuse (Revised by G.

Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill.

- Peavy H. S., Rowe D. R., and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Edition.
- Nemerow N. L. and Dasgupta A., Industrial and Hazardous Waste Treatment, Van Nostrand Reinhold (New York).
- Arceivala S.J. and Asolekar S.R., Wastewater Treatment for Pollution Control and Reuse, Tata McGraw Hill.
- Eckenfelder, W. W., Industrial Water Pollution Control, McGraw-Hill.
- Nemerow, N. L., Zero Pollution for Industry: Waste Minimization through Industrial Complexes, John Wiley & Sons.
- Crites R. W., Middlebrooks E. J., Reed S. C., Natural wastewater Treatment Systems, CRC Taylor and Francis.
- Patwardhan A.D., Industrial Wastewater Treatment, PHI Learning
- S.R. Qasim, Edward and Motley and Zhu, H., "Water Works Engineering - Planning, Design and Operation", Prentice Hall, India.
- S. Vigneswaran and C. Visvanathan, "Water Treatment Processes: Simple Options", CRC Press.

Subject Code: CE6L106	Name: Environmental Economics	L-T-P: 3-0-0	Credit: 3
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Prerequisite: None

Introduction to Environmental Economics: Scope of the problem, Interaction between economy and environment, Economist's perspectives on environmental problems. Brief idea about Quality of natural Environment and Environmental problems (Air Pollution, Water Pollution, Toxic Emission, ecosystem health). Introduction to Environmental Policy Instruments: Choice of policy instrument, command and control instruments, taxation, tradable permits, Environmental performance bonds

Public and environmental goods, negative externality and market failure, Internalization
Environmental Valuation: Contingent valuation methods, travel cost method, hedonic price method

Economics of natural resources: Natural Resources (renewable and non-renewable), Population dynamics, extraction of non-renewable resources, depletion, resource modeling,

Green and Natural resource accounting: GDP, NDP and sustainable development, Environmental accounting

Social efficiency and benefit-cost analysis: Efficiency and competitive markets, supply, demand and efficiency, benefit and cost analysis

Sustainable development and irreversibility in environmental policy: definition, economical efficiency, economic growth and environment

Global Environmental Issues and policies: Climate Change: Causes; possible effects; costs of mitigating green house gas emissions; Carbon Trading, adaptation measures, Design of international agreements, Environmental conflict, bargaining and cooperation, Environmental issues and policies in India

Books:

- Kolstad C.D., Environmental Economics, Oxford University Press.
- Conrad J. M., Resource Economics. Cambridge University Press
- Bhattacharya R.N., Environmental economics: an Indian perspective, Oxford University Press, New Delhi.
- Hanley N., Shogren, J. F., and White, B., Environmental economics in theory and practice. Oxford university press, New York.
- Common M. and Stagi, S., Ecological Economics an introduction, Cambridge University Press.
- Grafton R. Q. and Adamowicz W., The economics of the environment and natural resources, Wiley Blackwell Publication.
- Baumol W.J. and Oates E.E., The Theory of Environmental Policy, Cambridge University Press
- Tietenberg T., Environmental Economics and Policy, Addison-Wesley

Subject Code: CE6L107	Name: Environmental Hydraulics	L-T-P: 3-1-0	Credit: 4
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Prerequisite: None

Introduction to the principles of fluid dynamics, continuity, momentum and energy equations, Basic concepts in friction and flow in pipes, Flow formulation, turbulent and viscous flow, Hardy-Cross, Tong O Conner and other methods of analysis of pipe networks, Basic concepts in open channel hydraulics, Energy and momentum equations, critical flow, channel control and transitions, uniform flow, gradually varied flow, flow profiles and their computation, unsteady flow, hydraulic jumps, Design of drainage systems, Ground water hydraulics, estimation of aquifer parameters, confined and unconfined aquifers, steady and unsteady flow into wells, Dupuit approximations, single and multi-well system, well losses, recharging, well developments etc., movement of pollutants in ground water and wastewater treatment plants hydraulics. Different Flow measurement devices in channels and pipes

Books

- Chow V T, Flow through open channel, McGraw-Hill, 1973.
- Ranga Raju K. G., Flow through Open Channels, Second edition, TATA McGraw-Hill, 1997.
- Garde R. J. and Ranga Raju K. G., Mechanics of sediment transportation and alluvial stream problems, Third edition, New Age International (P) Limited, New Delhi, 2000.
- Bhave P. R., Analysis of Flow in Water Distribution Network, Technomic Publishing Co., Lancaster, USA, 1996.
- Todd D. K. Groundwater Hydrology , John Wiley publishers , 2004
- Jacob and Bear, Hydraulics of Groundwater, McGraw Hill, 1997
- Raghunath, Groundwater & Well Hydraulics, Wiley Eastern Ltd, New Delhi, 1992

Subject Code: CE6L108	Name: Solid Waste Management	L-T-P: 3-0-0	Credit: 3
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Prerequisite: None

Solid waste management: Sources, Composition and Properties of Municipal Solid Waste, Engineering principles; Generation, Onsite handling, storage and processing including segregation; Collection, Recycling, Transfer and transport, Waste processing, Recovery of resources, Waste processing technologies, Biological, chemical and thermal technologies - Composting, Anaerobic digestion, Incineration and pyrolysis, Disposal of solid waste including sanitary landfill, planning, siting, design, closure and post-closure monitoring; Regional/Integrated solid waste management related issues. Principles of E-waste Management. Biomedical waste: Regulatory framework, categorization; generation, collection, transport, treatment and disposal.

Hazardous Waste Fundamentals, Definition, Classification, Generation, Regulatory process, Current Management Practices, Treatment and Disposal Methods, Physicochemical processes, Biological processes, Stabilization and solidification; Thermal methods; Land disposal, Remediation of Contaminated Sites.

Books

- Tchobanoglous G., Theisen H., and Vigil S.A., Integrated Solid Waste Management: Principles and Management Issues, McGraw Hill Book Company, 1993.
- Peavy H. S., Rowe D. R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill International Edition.
- LaGrega, M.D., Buckingham P.L., and Evans J.C., Hazardous Waste Management, McGraw-Hill International Editions, 1994.
- Martin E.J. and Johnson J.H., Hazardous Waste Management Engineering, van Nostrand-Reinhold, 1987.
- Wentz C.A., Hazardous Waste Management, 2nd Edition, McGraw Hill, 1995
- Vesilind P.A., Worrell W and Reinhart, Solid waste Engineering, Thomson Learning Inc., Singapore, 2002.
- CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.
- Bhatia, S. Solid and Hazardous Waste Management, Atlantic Publishers & Distributors

Subject Code: CE6L109	Name: Industrial Pollution Prevention	L-T-P: 3-0-0	Credit: 3
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Prerequisite: None

Principles and techniques for industrial pollution prevention and waste minimization; Nature and characteristics of industrial wastes; Prevention versus control of industrial pollution; Source

reduction tools and techniques: raw material substitution, toxic use reduction and elimination, process modification and procedural changes; Recycling and reuse; Opportunities and barriers to cleaner technologies; Pollution prevention economics; Waste audits, emission inventories and waste management hierarchy for process industries; Material balance approach; Material and process mapping approach; Emission sources; Estimation of fugitive emissions; Environmental impact of VOCs; Energy and resource (material and water) audits for efficient usage and conservation. Unit operations in separation technology; Pollution prevention for unit operations: Boilers and Heat Exchangers; Storage tanks; Distillation columns; Application of separation technologies for pollution prevention; Process optimization for cleaner industrial processes: Flow sheet analysis: qualitative and quantitative approaches using mass exchange networks; Thermodynamic constraints to waste minimization; Holistic and critical technology assessment; Environmental performance indicators; Concept of industrial ecology and symbiosis of eco-parks. Case studies on industrial applications of cleaner technologies in chemical, metallurgical, pulp and paper, textile, electroplating, leather, dairy, cement and other industries. Presently used wastewater treatment systems such as MBR, MBBR, SBR, UASB reactor, Anammox, etc

Books

- Freeman H. M. Industrial Pollution Prevention Handbook, McGraw Hill.
- Shen T. T., Industrial Pollution Prevention, Springer
- Bishop P.E. Pollution Prevention: Fundamentals and Practice, McGraw Hill.
- Allen D.T. and Rosselot, K.S. Pollution Prevention for Chemical Processes, John Wiley.
- Allen D.T., Bakshani, N. and Rosselot, K.S., Pollution Prevention: Homework and Design Problems for Engineering Curricula, American Institute for Pollution Prevention, and Center for Waste Reduction Technologies.
- Johansson A., Clean Technology, Lewis Publishers, Boca Raton.
- Theodore, L. and McGuinn, Y. C. Pollution prevention, Van Nostrand Reinhold, New York.
- Eckenfelder, W. W., Industrial Water Pollution Control, McGraw-Hill.
- Nemerow, N. L., Zero Pollution for Industry: Waste Minimization through Industrial Complexes, John Wiley & Sons.

Subject Code: CE6L110	Name: Environmental Chemistry and Microbiology	L-T-P: 3-1-0	Credit: 4
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Prerequisite: None

Environmental chemistry-basic concepts from general chemistry, Chemical equations, chemical reactions, calculation from chemical reactions, solutions, activity and activity coefficients, Chemical Equilibria and Kinetics Fundamentals, Acid-Base equilibria - fundamentals, equilibrium diagrams, Acidity, Alkalinity, Buffers and Buffer Intensity, Chemical equilibrium calculations, pC-pH diagram, Langelier index, Solubility diagram, Oxidation and Reduction equilibria.

Water and wastewater quality parameters and their analysis, Basic concepts of quantitative analytical chemistry, instrumental methods of analysis.

Types of microorganisms found in the environment, Metabolic classification of organisms, Enzyme and enzyme kinetics, indicator organisms, coliforms - fecal coliforms - E.coli, Streptococcus fecalis differentiation of coliforms - significance - MPN index, M.F. technique, standards, Microbiological Parameter Analysis, Measurements and Isolation of Microorganism, Different Cultures, Media and Techniques of Staining and Enumeration of microorganism, Staining and detection of microbes, Methods of enumerating microbes, Multiple tube fermentation technique, Membrane filter technique.

Books

- Sawyer, C.N. and McCarty, P.L., and Parkin, G.F. Chemistry for Environmental Engineers, 4th Edition, McGraw Hill, New Delhi, 1994.
- Benefield, Judkins and Weand - Process Chemistry for Water and Wastewater Treatment, Prentice Hall
- Maier R. M., Pepper I. L., and Gerba C. P., Environmental Microbiology, Second Edition, Elsevier- AP, 2009.
- Pelczar, Jr, M.J., Chan, E.C.S., Krieg, R.N., and Pelczar M. F, Microbiology, 5thEdn., Tata McGraw-Hill Publishing Company Limited, New Delhi, 1996.

<ul style="list-style-type: none"> Rittman B, McCarty P L McCarty P, Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000 			
Subject Code: CE6L111	Name: Highway Environment and Noise Pollution Control	L-T-P: 3-1-0	Credit: 4
<p>Prerequisite: None</p> <p>Sources and Classification of Noise, Effects of Noise, Noise Measuring Instruments and Survey: Sound level meter, audiometer, dose meter, octave band analyzer; Noise Indices: Leq, Ldn, TNI, NII, Noise Control Measures: noise control at source, path and receiver, acoustic barriers, enclosures, control of machinery noise, community and industrial noise control strategies; Noise Standards in India and Abroad; Noise Impact Assessment and Prediction Techniques.</p> <p>Human factors in road user behaviour, vehicle characteristics, driver, road and environment. Environmental Factors: impacts and mitigation measures of air quality, noise, severance, visual intrusion, impact on water quality, use of limited resources, impact on flora & fauna, vibration, dust ; Transport related pollution. Urban and non urban traffic noise sources, Noise pollution. Traffic calming, Measures, Road transport related air pollution, sources of air pollution, effects of weather conditions, Vehicular emission parameters, pollution standards, measurement and analysis of vehicular emission; control measures; EIA requirements of Highways projects.</p> <p>Books</p> <ul style="list-style-type: none"> Tripathy D.P., Noise Pollution, APH Pub., New Delhi. Sengupta M., Environmental Engineering (Vol. 2), CRC Press, Boca Raton. Pandey G.N. and Carney G.C., Environmental Engineering, Tata McGrawHill, New Delhi. Beranek L., Noise and Vibration Control, McGrawHill Co, NY. Trivedy P.R. Int. Encyclopedia of Ecology & Environment, Noise Pollution (Vol. 13), IIEE, New Delhi. Wark K., Warner C.F. and Davi, W.T., Air Pollution: Its Origin and Control, Prentice Hall. Boubel R.W. Fundamentals of Air Pollution, Academic Press. Vallero D., Fundamentals of Air Pollution, Academic Press. Canter L., Environmental Impact Assessment, McGraw-Hill International. 			
Subject Code: CE6L112	Name: Environmental Nanotechnology and Applications	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Introduction to nanotechnology, Nanotechnology for reduced wasteand improved energy efficiency, Nanotechnology based water treatment strategies, nanomaterials-microporous materials, carbon nanotubes, photocatalystsetc, synthesis of nanocrystals and membranes, properties, environmental application, Development of carbon nanotubes (CNTs), structure and properties of fullerene, C60, carbon nanotube and fibre, CNT synthesis - mechanism and commercial techniques, organized assembly of CNTs, possible applications of CNTs, Environmental applications - adsorption, hydrogen storage, photocatalysts preparation and characterizationUV induced hydrophobicity, modified photocatalysts, application of photocatalysts in environmental treatment, nanoscale biometal for subsurface remediation, Sensing materials, introduction to novel sensing materials, operation principle, sensors - mass and optical sensors, nano-sensing systems and applications.</p> <p>Books</p> <ul style="list-style-type: none"> Wiesner M., Bottero J-Y., Environmental Nanotechnology : Applications and Impacts of Nanomaterials Applications and Impacts of Nanomaterials, McGraw Hill Professional. Pradeep T., Textbook of Nanoscience and Nanotechnology, McGraw Hill Education (India) Private Limited Mittal V., Nanocomposites with Biodegradable Polymers: Synthesis, Properties, and Future perspectives., Oxford University Press 			
Subject Code: CE6L113	Name: Water Quality Modeling and Management	L-T-P: 3-1-0	Credit: 4
<p>Water quality description, various characteristics of water, water quality criteria and standards, elements of reaction kinetics, spatial and temporal aspects of contaminant transport, transport mechanism-advection, diffusion, dispersion; River and streams, convective diffusion equation</p>			

and its application. Estuaries, Estuarine hydraulics, Estuarine water quality models; Lakes and reservoirs, eutrophication; Numerical/mathematical modelling of environmental systems, subsystems, and pollutant transport processes Contaminant transport in unsaturated flows, solute transport models for conservative species, solute transport in spatially variable soils; Contaminant transports in ground water advection, dispersion, one dimensional transport with linear adsorption, dual porosity models, numerical models, bio degradation reaction; Water quality management, socio-economic aspects of water quality management, management alternatives for water quality control, waste load allocation process, lake quality management, ground water remediation.

Books

- Ramaswami A., Milford J. B., Small M. J., Integrated Environmental Modeling - Pollutant Transport, Fate, and Risk in the Environment John Wiley & Sons, 2005.
- Burrough P.A. and McDonnell R.A., Principles of Geographical Information Systems, Oxford University Press, 1998.
- Snape J.B., Dunn I.J., Ingham J., and Prenosil J., Dynamics of environmental bioprocesses, modelling and simulation Weinheim: VCH, 1995.
- International Water Association - Activated sludge modelling ASM1 and ASM2
- Chapra S. C., Surface Water Quality Modeling, McGraw-Hill, Inc., New York, 1997.
- Garde R. J., and Ranga Raju K. G., Mechanics of sediment transportation and alluvial stream problems, Third edition, New Age International (P) Limited, New Delhi
- Thomann, R.V. and Mueller, J.A. Principles of surface water quality modeling and control, Pearson, 1987
- Chapra, S.C. Surface water quality modelling, Waveland Press, INC., 1997
- Schnoor, J.L., Environmental Modeling Wiley, John & Sons, 1997
- Thomann, R.V., Systems Analysis and Water Quality Management, McGraw Hill, 1972

Subject Code: CE6L513	Name: Water Resources Planning and Management	L-T-P: 3-1-0	Credit: 4
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Pre-requisites: None

Introduction to issues in planning and management; Role of water resources systems modelling; Decision support systems (DSS); Simulation models; Optimization methods; Dynamic programming; Application in reservoir operation, etc.; Linear programming; Multi-objective optimization; Modelling uncertainty; Sensitivity and uncertainty analyses; Advances in modelling; Fuzzy optimization-applications in reservoir storage, water quality studies, etc.; Artificial neural networks; Genetic algorithms; Data mining; Flood management; Flood plain modelling; Managing risk; Risk reduction; Decision support and prediction; Reliability-resilience-vulnerability (RRV) analysis; Drought management; Causes, types and impacts; Impact of climate change; Drought monitoring; Drought triggers; S-D-F analysis of droughts using copulas.

Books:

- Loucks, D. P., and Van Beek, E., Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications, the UNESCO, Paris, 2005.
- Loucks, D. P., Stedinger, J.R., and Haith, D. A., Water Resources Systems Planning and Analysis, Prentice-Hall, NJ, 1981.
- Vedula, S., and Mujumdar, P. P., Water Resources Systems: Modelling Techniques and Analysis, Tata McGraw Hill, New Delhi, 2007.
- Jain, S.K., and Singh, V. P., Water Resources Systems Planning and Management, Developments in Water Science, Vol. 51, Elsevier Science, New York, 2003.
- Govindaraju, R. S., and Rao, A. R., Artificial Neural Networks in Hydrology, Water Science and Technology Library, Volume 36, Springer Netherlands, 2000.
- Raju, K. S., and Kumar D. N., Multicriterion Analysis in Engineering and Management, Prentice-Hall, India, 2014.

Subject Code: CE6L514	Name: Design of Pipe Networks	L-T-P: 3-1-0	Credit: 4
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Pre-requisites: None

Introduction to flow hydraulics and network analysis; Basic principles of pipe flow; Fittings and valves; Pipe network analysis, pipe network geometry, branched and looped networks; Multi-Input source water network analysis; Cost considerations, Life cycle costing, Relative cost factor; General principles of network synthesis, constraints, parameters for network sizing, reliability considerations; Water transmission lines, gravity mains, pumping mains; Water distribution mains; Single-input source branched systems; Single-input source looped systems; Multi-input source branched systems; Multi-input source looped systems; Decomposition of a large multi-input, looped network; Optimal water supply zone size.

Books:

- Swamee, P. K., and Sharma, A. K., Design of Water Supply Pipe Networks, John Wiley & Sons, Inc., New Jersey, 2008.
- Bhave, P. R., Analysis of Flow in Water Distribution Networks, Technomic Publishing; Lancaster, 1991.
- Surhone, L. M., Tennoe, M. T., Henssonow, S. F., Pipe Network Analysis, VDM Publishing, Germany, 2010.
- Jeppson, R. W., Analysis of flow in pipe networks, Ann Arbor Science Publishers, Inc., Ann Arbor, 1976.
- Mays, L. W., Water Distribution Systems Handbook, McGraw-Hill Education, New York, 1999.

Subject Code: CE6L515	Name: GIS and Remote Sensing Applications in Civil Engineering	L-T-P: 3-0-0	Credit: 3
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Pre-requisites: None

Remote sensing; Energy source; Spectral signatures; Remote sensing satellites and sensors; Radar image interpretation; Digital image processing; Image classification; Principal component transformation; Applications in watershed management, flood management, groundwater quality, reservoir sedimentation, irrigation management. Geographic information systems (GIS); Raster and vector data; GIS for Surface-Water Hydrology; Digital elevation models; Hydrographic vector data; Arc-hydro model; GIS for groundwater modeling; GIS for flood plain management; HEC-RAS and HEC-GeoRAS; Case studies.

Books:

- Lillesand, T., Kiefer, R. W., and Chipman, J., Remote Sensing and Image Interpretation, Seventh Edition, John Wiley & Sons, New York, 2015.
- Burrough, P. A., and McDonnell, R. A., Principles of Geographical Information Systems, Second Edition, Oxford University Press, Oxford, 1998.
- Richards, J. A., Remote Sensing Digital Image Analysis: An Introduction, Fifth Edition, Springer-Verlag Berlin Heidelberg, 2013.
- Johnson, L. E., Geographic Information Systems in Water Resources Engineering, CRC Press, Boca Raton, 2008.

Subject Code: CE6L516	Name: Non-Point Source Pollution of Water Resources	L-T-P: 3-0-0	Credit: 3
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Pre-requisites: None

Basic concept of water pollution; Water quality standards pertaining to drinking, irrigation and aquatic life; Water quality analysis methods and instruments used; Concept and behaviour of point and nonpoint source pollution (NPS); Sources of NPS pollution; Pathways and assessment of NPS pollutants; linkage between water pollution and hydrology; Application of hydrologic models in NPS pollution assessment at watershed scale; Quantification and control of NPS pollution from agricultural watersheds; Nitrogen, Phosphorus, pesticides and water quality impacts; Impacts of mining and forestry; Watershed-scale NPS pollution models; Optimum management strategy; Best management practices for NPS pollution control.

Books:

- Novotny, V., Water Quality: Diffuse Pollution and Watershed Management, Second Edition, John Wiley and Sons, New York, 2003.

<ul style="list-style-type: none"> Ritter, W. F., Shirmohammadi, A., Agricultural Nonpoint Source Pollution: Watershed Management and Hydrology, CRC Press, Boca Raton, 2001. Brooks, K. N., Ffolliott, P., F., and Magner, J. A., Hydrology and the Management of Watersheds, Fourth Edition, Wiley-Blackwell, New York, 2012. Das, M. M., Saikia, M., Watershed Management, PHI Learning, Delhi, 2012. 			
Subject Code: CE6L518	Name: Integrated Watershed Management	L-T-P: 3-0-0	Credit: 3
<p>Prerequisite: None</p> <p>Introduction to integrated approach for the management of watersheds; Watershed hydrology: runoff and sediment load estimation; Instrumentation, and monitoring of hydro-meteorological variables at watershed-scale; Discharge measurement, sediment (suspended and bed load) measurement; Control of soil erosion; GIS for integration of different aspects of watersheds; Rainwater management: rainwater harvesting, artificial recharge, types and design of water harvesting and recharge structures; Irrigation management: use of conserved water; Land degradation, soil quality and water quality aspects, soil conservation strategies, water conveyance structures-spillways, culverts, etc.; Droughts: causes, types, drought indices, control and adaptation strategies; Drainage: estimation of drainage coefficient, design of surface and subsurface drainage systems, control of soil salinity; Climate change: general circulation models (GCMs), IPCC climate change scenarios, impacts of climate change and land use change on watersheds; Case studies</p> <p>Books:</p> <ul style="list-style-type: none"> Brooks, K. N., Ffolliott, P., F., and Magner, J. A., Hydrology and the Management of Watersheds, Fourth Edition, Wiley-Blackwell, New York, 2012. Das, M. M., Saikia, M., Watershed Management, PHI Learning, Delhi, 2012. Ven Te Chow, Maidment, D. and Mays, L.W., Applied Hydrology, Second Edition, McGraw-Hill Inc., New York, 2013. Heathcote, I. W., Integrated Watershed Management: Principles and Practice, Second Edition, John Wiley and Sons, Inc., NJ, 2009. Gregersen, H. M., Ffolliott, P. F., Brooks, K. N., Integrated Watershed Management: Connecting People to Their Land and Water, CAB International, UK, 2007. Climate Change 2014: Impacts, Adaptation and Vulnerability, Working Group Report II, IPCC Fifth Assessment Report of the IPCC. Climate Change 2014: Mitigation of Climate Change, Working Group Report III, IPCC Fifth Assessment Report of the IPCC. Mujumdar, P. P., and Kumar D. N., Floods in a Changing Climate: Hydrologic Modeling, International Hydrology Series, Cambridge University Press, Cambridge, U.K., 2012. 			
Subject Code: CE6L216	Name: Geotechnics of Polluted Sites	L-T-P: 3-0-0	Credit: 3
<p>Pre-requisites: None</p> <p>Basic concepts related to soil pollution; Sources of pollution: industrial areas, agricultural, municipal, nuclear; types of contaminants; Role of physical and chemical properties of soil in contamination; Factors effecting retention and transport of contaminants; Soil sampling collection and characterization: sampling of contaminated soil, site investigation and monitoring parameters, exploratory site investigation, methods of analysis/identification, sample handling, preservation, transportation and storage; Non-destructive techniques of site characterization: electrical and thermal properties, GPR; Soil and ground water remediation: conceptual approach to soil and ground water remediation, risk assessment, methodologies and selection of treatment models; Soil remediation: excavation, soil washing, stabilization/solidification; Soil vapor extraction, electrokinetic remediation, thermal desorption, vitrification; Bioremediation, phytoremediation, soil fracturing; Groundwater Remediation: selection of technique, pump and treat, in-situ flushing; Groundwater Remediation: permeable reactive barriers, in-situ air sparging, monitored natural attenuation, bioremediation; Green and sustainable remediation;</p>			

Case studies on polluted sites and issues related to environment.

Books

- Sharma, H.D., and Reddy, K.R., Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004, 992p. (ISBN: 0-471-21599-6).
- Reddy, K.R., and Cameselle, C. Editors, Electrochemical Remediation Technologies for Polluted Soils, Sediments and Groundwater, John Wiley & Sons, Inc., Hoboken, New Jersey, 2009, 760p. (ISBN: 0-470-38343-7).
- Reddy, K.R., and Adams, J.A., Sustainable Remediation of Contaminated Sites, Momentum Press, New York, December 2014 (ISBN: 9781606505205).
- Rowe R.K., "Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London, 2000.

Subject Code: CE6L217	Name: Geotechnics of Waste and waste Containment	L-T-P: 3-0-0	Credits: 3
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Pre-requisites: None

Sources and types of wastes; Environmental and engineering properties of wastes; New and developing government policies; Beneficial re-use of wastes; Fundamentals of waste-soil interaction; Containment systems and basic principles; Lining and capping systems; Leachate and gas collection systems; Compacted soil liners; Admixed soil liners; Geosynthetic clay liners; Geomembranes; Drainage layers; Geosynthetic composites; Seepage flow; Contaminant transport; Landfill settlement; Landfill slope stability; Conventional caps, ET caps; Ground water monitoring; Landfill gas; Post-closure monitoring; Bioreactor landfills; Landfill mining; End-use of closed landfills; Impoundments; Integrated waste management and alternative landfills.

Books:

- H.D. Sharma and K.R. Reddy Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley, New Jersey, 2004.
- R.N. Yong, Geoenvironmental Engineering: Contaminated Ground: Fate of Pollutions and Remediation, Thomson Telford, 2000.
- L.N. Reddy & H.I. Inyang, Geoenvironmental Engineering: Principles and Applications, Marcel Dek, 2000.
- Raju, V.S., Datta, M., Seshadri, V., and Agarwal, V.K. (1996) (Eds.), "Ash Ponds and Ash Disposal Systems", Narosa Publishers, Delhi, 424 pages.
- Datta, M. (1997) (Ed.), "Waste Disposal in Engineered Landfills", Narosa Publishers, Delhi, 231 pages.
- Datta, M., Parida, B.P., Guha, B.K. and Sreekrishnan, T., (1999) (Eds.), "Industrial Solid Waste Management and Landfilling Practice", Narosa Publishers, Delhi, 204 pages.
- David E. Daniel, Geotechnical Practice for Waste Disposal, Published by Chapman & Hall, London, 1993.
- Bagchi, A., "Design of landfills and integrated solid waste management" John Wiley & Sons, Inc., USA, 2004.
- Qian, X., R. M. Koerner, and D. H. Gray. Geotechnical Aspects of Landfill Design and Construction. New Jersey: Prentice Hall, Upper Saddle River, 2002.

Subject Code: ES6L104	Name: Groundwater Modeling and Simulation	L-T-P: 3-1-0	Credit: 4
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Pre-requisites: None

Data requirement; Aquifer configuration and hydraulic parameters; Subsurface Groundwater flow equation; Conceptual modelling; Aquifer geometry; Model boundary; Model design; Model calibration; Simulation techniques; Solute transport modelling; Groundwater modelling examples from India.

Books:

- Damena, T, Mathematical Modelling and Simulation on Groundwater Flow: The study of groundwater flow with computer aided mathematical methods, LAP LAMBERT Academic Publishing.
- Refsgaard, J.C., Kovar, K. Haarder, E. and Nygaard, E., Calibration and Reliability in Groundwater Modelling: Credibility of Modelling (IAHS Proceedings & Reports), International Association of Hydrological Sciences.
- Rushton, K.R., Groundwater Hydrology: Conceptual and Computational Models, Wiley.

Subject Code: MA6L001	Name: Mathematical Methods	L-T-P: 3-1-0	Credit: 4
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Prerequisite: None
 Probability and Statistics : Random variables (rv) and their properties, some standard discrete and continuous rv, Expectation, Variance, moments, moment generating functions, functions of a rv, their distribution and moments, joint, marginal and conditional distribution and independence of rvs, Hypothesis testing.
 Numerical solutions of systems of linear equations: Gauss elimination, LU decomposition, Gauss-Jacobi and Gauss-Seidel methods.
 Numerical methods of ODE and PDE: Runge-Kutta and finite difference methods for ODE, Finite difference methods for solving 2-D Laplace's equation, Poisson's equation, 1-D heat equation : Bender Schmidt, Crank Nicholson method and Du Fort Frankel methods, 1-D wave equation using Explicit method. Consistency and stability analysis.
Books:

- Grawel B.S. Numerical Methods
- Jain M.K., Iyengar S.R.K. and Jain R.K., Numerical Methods-problem and solutions, Wiley Eastern Limited, 2001.
- Ross S. Introduction to Probability Models, Wiley India
- Gun A.M., Gupta M.K. and Gupta B.S. Fundamentals of Statistics
- Hayter A.J., Probability and Statistics, Duxbury, 2002
- Scarborough J.B., Numerical mathematical analysis, Oxford & IBH Publishing Co.Pvt.,2000
- Hamming R.W., Numerical Methods for Scientist and Engineers, McGraw Hill, 1998
- Mathews J.H. and Fink, K.D., Numerical Methods using MATLAB, Pearson Education, 2004.

Subject Code: MA6L002	Name: Advanced Techniques in Operation Research	L-T-P: 3-1-0	Credit: 4
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Prerequisite: None
 One variable unconstrained optimization, multivariable unconstrained optimisation, Karush-Kuhn-Tucker (KKT) conditions for constrained optimization, quadratic programming, separable programming, convex and non convex programming, steepest and Quasi-Newton method.
 Dynamic Programming: Characteristics of dynamic problems, deterministic dynamic programming and probabilistic dynamic programming, Network analysis, Shortest path problems, minimum spanning tree problem, maximum flow problem, minimum cost flow problem, network simplex, interior point methods, stochastic programming, Nonlinear goal programming applications, Geometric Programming.
 Multi-objective Optimization Problems: Linear and non linear programming problems, Weighting and Epsilon method, P-norm methods, Gradient Projection Method, STEM method, Convex Optimization.
Books

- Rao S.S., Engineering Optimization Theory and Practices, John Wiley and Sons, 2009
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