CURRICULUM AND SYLLABI

B. Tech.

in

CIVIL ENGINEERING

COURSES

(I to VIII Semesters)

(Applicable to 2017 admission onwards)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

CALICUT - 673601

KERALA, INDIA

The Programme Educational Objectives (PEOs) of
B. Tech. in Civil Engineering

PEO1	Provide a strong foundation in Mathematics, Basic Sciences and Engineering fundamentals to the students, enabling them to excel in the various careers in Civil Engineering.
PEO2	Impart necessary theoretical and practical background in Civil Engineering to the students, so that they can effectively compete with their contemporaries in the National / International level.
PEO3	Motivate and prepare the Graduates to pursue higher studies and research, thus contributing to the ever increasing academic demands of the country.
PEO4	Enrich the students with strong communication and interpersonal skills, broad knowledge and an understanding of multicultural and global perspectives, to work effectively in multidisciplinary teams, both as leaders and team members.
PE05	Facilitate integral development of the personality to deal with ethical and professional issues, taking into account, the broader societal implications of Civil Engineering, and also to develop ability for independent and lifelong learning.

The Programme Outcomes (POs) of B. Tech. in Civil Engineering

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The Programme Specific Outcomes (PSOs) of

B. Tech. in Civil Engineering

PSO1	The students will attain competence in mathematics, science, and modern engineering tools for the solution of civil engineering problems
PSO2	The students will have the ability to design and conduct experiments, analyse and interpret data, and synthesise valid conclusions for problems related to civil engineering and sustainable infrastructure development
PSO3	The students will have the ability to identify, formulate, research through relevant literature review, and solve civil engineering and sustainable infrastructure development problems reaching substantiated conclusions
PSO4	The students will be able to function effectively within multi-disciplinary teams and apply the fundamental principles of civil engineering for sustainable development
PSO5	The student will gain awareness on the impact of civil engineering solutions in a societal context and able to respond effectively to the needs for sustainable development

CURRICULUM

The total minimum credits for completing the B. Tech. programme in Civil Engineering is **160**.

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES

The structure of B.Tech. programmes shall have the following Course categories:

Sl. No.	Course Category	Number of Courses	Credits
1	Mathematics (MA)	4	12
2	Science (BS)	5	10
3	Humanities (HL)	3	9
4	Basic Engineering (BE)	6	15
5	Professional Core (PC)	33	90
6	Open Electives (OE)	2	6
7	Departmental Electives (DE)	4	12
8	Other Courses (OT)	4	6
	Total	61	160

COURSE REQUIREMENTS

1. MATHEMATICS (MA)

Sl. No.	Course Code	Course Title	L	T	P	Credits
1	MA1001D	Mathematics I	3	1	0	3
2	MA1002D	Mathematics II	3	1	0	3
3	MA2001D	Mathematics III	3	1	0	3
4	MA2002D	Mathematics IV*	3	1	0	3
	Total		12	4	0	12

*Mathematics IV will be branch specific.

2. SCIENCE (BS)

Sl. No.	Course Code	Course Title	L	T	P	Credits
1	PH1001D	Physics	3	0	0	3
2	PH1091D	Physics Lab	0	0	2	1
3	CY1001D	Chemistry	3	0	0	3
4	CY1094D	Chemistry Lab	0	0	2	1
5	BT1001D	Introduction to Life Science	2	0	0	2
	Total		8	0	4	10

3. HUMANITIES (HL)

Sl. No.	Course Code	Course Title	L	T	P	Credits
1	MS1001D	Professional Communication	3	0	0	3
2	MS3003D	Economics & Management	3	1	0	3
3	CE4004D	Construction Management & Quantity Surveying	3	1	0	3
	Total		9	0	0	9

4. BASIC ENGINEERING (BE)

Sl. No.	Course Code	Course Title	L	T	P	Credits
1	ZZ1001D	Engineering Mechanics	3	0	0	3
2	ZZ1002D	Engineering Graphics	2	0	2	3
3	ZZ1003D	Basic Electrical Sciences	3	0	0	3
4	ZZ1004D	Computer Programming	2	0	0	2
5	ZZ1091D	Workshop I	0	0	3	2
6	ZZ1092D	Workshop II	0	0	3	2
	Total		8	0	8	15

5. OTHER COURSES (OT)

Sl. No.	Course Code	Course Title	L	T	P	Credits
1	ZZ1093D	Physical Education	0	0	2	1
2	ZZ1094D	Value Education	0	0	2	1
3	ZZ1095D	NSS	0	0	2	1
4	CE2010D	Environmental Studies	3	0	0	3
	Total		3	0	6	6

6. PROFESSIONAL CORE (PC)

Sl. No.	Course Code	Course Title	Prerequisites	L	T	P	Credits
1	CE2001D	Mechanics of Solids	ZZ1001D	3	0	0	3
2	CE2002D	Mechanics of Fluids	NIL	3	0	0	3
3	CE2003D	Building Technology	NIL	3	1	0	3
4	CE2004D	Surveying	NIL	4	0	0	4
5	CE2005D	Engineering Geology	NIL	2	1	0	2
6	CE2091D	Surveying Practical	CE2004D	0	0	3	2
7	CE2092D	Material Testing Lab I	NIL	0	0	3	2
8	CE2006D	Open Channel Hydraulics & Hydrology	CE2002D	3	0	0	3
9	CE2007D	Functional Design of Buildings	CE2003D	3	1	0	3

Sl. No.	Course Code	Course Title	Prerequisites	L	T	P	Credits
10	CE2008D	Structural Analysis I	CE2001D	3	0	0	3
11	CE2009D	Geotechnical Engg. I	NIL	3	1	0	3
12	CE2093D	Building Design and Drawing	CE2003D	0	0	3	2
13	CE2094D	Material Testing Lab II	CE2001D	0	0	3	2
14	CE3001D	Structural Analysis II	CE2008D	3	0	0	3
15	CE3002D	Structural Design I	NIL	3	1	0	3
16	CE3003D	Numerical Methods in Civil Engineering	NIL	3	0	0	3
17	CE3004D	Geotechnical Engg. II	CE2009D	3	1	0	3
18	CE3005D	Transportation Engg. I	NIL	3	0	0	3
19	CE3091D	Transportation Engg. Lab	CE3005D	0	0	3	2
20	CE3092D	Geotechnical Engg Lab	CE2009D	0	0	3	2
21	CE3006D	Water Resources Engineering I	CE2006D	3	0	0	3
22	CE3007D	Structural Design II	NIL	3	0	0	3
23	CE3008D	Transportation Engg. II	NIL	3	1	0	3
24	CE3009D	Environmental Engg. I	NIL	3	1	0	3
25	ME3095D	Fluid Mechanics and Fluid Machinery Laboratory	CE2002D	0	0	3	2
26	CE3093D	Computer Applications Laboratory	All Courses till & inc. 4th Semester	0	0	3	2
27	CE4001D	Environmental Engg. II	CE3009D	3	1	0	3
28	CE4002D	Structural Analysis III	CE3001D	3	0	0	3
29	CE4003D	Water Resources Engineering II	CE2006D	3	0	0	3
30	CE4091D	Environmental Engg Lab	CE3009D	0	0	3	2
31	CE4092D	Seminar	NIL	0	0	2	1
32	CE4098D	Project: Part 1		0	0	6	3
33	CE4099D	Project: Part 2	CE4098D	0	0	10	5
	Total			63	21	45	90

7. DEPARTMENTAL ELECTIVES (DE)

Sl. No.	Course Code	Course Title	Prerequisites	L	T	P	Credits
1	CE3021D	Statistics, Probability and Reliability Methods in Engineering	NIL	3	0	0	3
2	CE3022D	Concrete Technology	NIL	3	0	0	3
3	CE3023D	Ground Improvement	NIL	3	1	0	3
4	CE3024D	Reinforced Earth & Geotextiles	NIL	3	1	0	3
5	CE3025D	Earth & Earth retaining Structures	CE3004D	3	1	0	3
6	CE3026D	Environmental Geotechnics	NIL	3	1	0	3
7	CE3027D	Water Conveyance Systems	CE2006D	3	0	0	3
8	CE3028D	Hydraulic Machinery	CE2002D	3	0	0	3
9	CE3029D	Remote Sensing and GIS	NIL	3	0	0	3
10	CE3030D	Groundwater Hydrology	NIL	3	0	0	3
11	CE3031D	Finite Element Method in Fluid Flow	CE2002D or Equivalent	3	0	0	3
12	CE3032D	Statistical Techniques in Water Resources Engineering	NIL	3	0	0	3
13	CE3033D	Soft Computing Techniques	NIL	3	0	0	3
14	CE3034D	Coastal Engineering and Coastal Zone Management	CE2002D	3	0	0	3
15	CE3035D	Transportation and Landuse	NIL	3	0	0	3
16	CE3036D	Transportation Planning	NIL	3	0	0	3
17	CE3037D	Pavement Analysis and Design	CE3005D	3	0	0	3
18	CE3038D	Traffic Engineering	CE3005D	3	0	0	3
19	CE3039D	Environmental Law and Policy	CE2010D or Equivalent	3	0	0	3
20	CE3040D	Air Pollution Control Engineering	CE2010D	3	0	0	3

Sl. No.	Course Code	Course Title	Prerequisites	L	T	P	Credits
21	CE3041D	Solid Waste Management	CE2010D	3	0	0	3
22	CE3042D	Pre-stressed Concrete Design	CE3002D	3	0	0	3
23	CE3043D	Advanced Concrete Design	CE3002D	3	0	0	3
24	CE3044D	Finite Element Analysis	NIL	3	0	0	3
25	CE3045D	Computational Elasticity	CE2001D	3	0	0	3
26	CE3046D	Advanced Surveying	CE2004D	3	0	0	3
27	CE4021D	Advanced Geotechnical Engineering	NIL	3	1	0	3
28	CE4022D	Soil Dynamics and Design of Machine Foundations	CE3004D	3	1	0	3
29	CE4023D	Earth & Rockfill Dam Engineering	NIL	3	1	0	3
30	CE4024D	Numerical Modelling in Geotechnical Engineering	NIL	3	1	0	3
31	CE4025D	Environmental Hydraulics	CE2002D & CE3009D	3	0	0	3
32	CE4026D	Environmental Impact Assessment of Civil Engineering Projects	CE2010D or Equivalent	3	0	0	3
33	CE4027D	Hydropower	CE2002D	3	0	0	3
34	CE4028D	Urban Hydrology and Drainage	CE2006D	3	0	0	3
35	CE4029D	Disaster Management	NIL	3	0	0	3
36	CE4030D	Hydroclimatology	NIL	3	0	0	3
37	CE4031D	Water Quality Modelling and Management	CE2006D & CE3009D	3	0	0	3
38	CE4032D	Optimisation of Engineering Systems	NIL	3	0	0	3
39	CE4033D	Pavement Evaluation and Management	NIL	3	0	0	3
40	CE4034D	Transportation Infrastructure Design	NIL	3	0	0	3

Sl. No.	Course Code	Course Title	Prerequisites	L	T	P	Credits
41	CE4035D	Traffic Flow Modelling	NIL	3	0	0	3
42	CE4036D	Road Safety and Management	NIL	3	0	0	3
43	CE4037D	Environmental Forensics	CE2010D	3	0	0	3
44	CE4038D	Environmental Risk Analysis	CE2010D	3	0	0	3
45	CE4039D	Environmental System Analysis	CE3009D	3	0	0	3
46	CE4040D	Advanced Wastewater Engineering	CE4001D	3	0	0	3
47	CE4041D	Geoinformatics	NIL	3	0	0	3
48	CE4042D	Advanced Structural Analysis	CE4002D	3	0	0	3
49	CE4043D	Advanced Steel Design	CE3007D	3	0	0	3
50	CE4044D	Seismic Design of Structures	NIL	3	0	0	3
51	CE4045D	Fracture Mechanics	CE2001D	3	0	0	3
52	CE4046D	Forensic Engineering and Rehabilitation of Structures	NIL	3	0	0	3
53	CE4047D	Dynamics of Structures	NIL	3	0	0	3
54	CE4048D	Maintenance and Rehabilitation of Constructed Facilities	NIL	3	1	0	3

8. OPEN ELECTIVES (OE)

Two elective courses to be credited from other departments.

Course Structure

Semester I

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA1001D	Mathematics I	3	1	0	3	MA
2	PH1001D / CY1001D	Physics / Chemistry	3	0	0	3	BS
3	MS1001D / ZZ1003D	Professional Communication / Basic Electrical Sciences	3	0	0	3	HL/BE
4	ZZ1001D / ZZ1002D	Engineering Mechanics / Engineering Graphics	3/2	0	0/2	3	BE
5	ZZ1004D / BT1001D	Computer Programming / Introduction to Life Science	2	0	0	2	BE/BS
6	PH1091D / CY1094D	Physics Lab / Chemistry Lab	0	0	2	1	BS
7	ZZ1091D / ZZ1092D	Workshop I / Workshop II	0	0	3	2	BE
8	ZZ1093D / ZZ1094D / ZZ1095D	Physical Education / Value Education / NSS	-	-	-	3*	OT
	Total Credits		14/ 12	1	5/8	17+3*	

*Note: Three courses of 1 credit each has to be credited within the first four semesters.

Semester II

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA1002D	Mathematics II	3	1	0	3	MA
2	CY1001D / PH1001D	Chemistry / Physics	3	0	0	3	BS
3	ZZ1003D / MS1001D	Basic Electrical Sciences / Professional Communication	3	0	0	3	BS/HL
4	ZZ1002D / ZZ1001D	Engineering Graphics / Engineering Mechanics	2/3	0	2/ 0	3	BE
5	BT1001D / ZZ1004D	Introduction to Life Science / Computer Programming	2	0	0	2	BS/BE
6	CY1094D / PH1091D	Chemistry Lab / Physics Lab	0	0	2	1	BS
7	ZZ1092D / ZZ1091D	Workshop II / Workshop I	0	0	3	2	BE
	Total Credits		12/ 14	1	8/ 5	17	

Semester III

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA2001D	Mathematics III	3	1	0	3	MA
2	CE2001D	Mechanics of Solids	3	0	0	3	PC
3	CE2002D	Mechanics of Fluids	3	0	0	3	PC
4	CE2003D	Building Technology	3	1	0	3	PC
5	CE2004D	Surveying	4	0	0	4	PC
6	CE2005D	Engineering Geology	2	1	0	2	PC
7	CE2091D	Surveying Practical	0	0	3	2	PC
8	CE2092D	Material Testing Lab I	0	0	3	2	PC
	Total Credits		18	6	6	22	

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	MA2002D	Mathematics IV	3	1	0	3	MA
2	CE2006D	Open Channel Hydraulics & Hydrology	3	0	0	3	PC
3	CE2007D	Functional Design of Buildings	3	1	0	3	PC
4	CE2008D	Structural Analysis I	3	0	0	3	PC
5	CE2009D	Geotechnical Engg. I	3	1	0	3	PC
6	CE2010D	Environmental Studies	3	0	0	3	OT
7	CE2093D	Building Design & Drawing	0	0	3	2	PC
8	CE2094D	Material Testing Lab II	0	0	3	2	PC
	Total Credits		18	5	6	22	

Semester V

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	CE3001D	Structural Analysis II	3	0	0	3	PC
2	CE3002D	Structural Design I	3	1	0	3	PC
3	CE3003D	Numerical Methods in Civil Engineering	3	0	0	3	PC
4	CE3004D	Geotechnical Engg. II	3	1	0	3	PC
5	CE3005D	Transportation Engg. I	3	0	0	3	PC
6		Elective I	3	0	0	3	DE/OE
7	CE3091D	Transportation Engg. Lab	0	0	3	2	PC
8	CE3092D	Geotechnical Engg. Lab	0	0	3	2	PC
	Total Credits		18	6	6	22	

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	CE3006D	Water Resources Engg. I	3	0	0	3	PC
2	CE3007D	Structural Design II	3	0	0	3	PC
3	CE3008D	Transportation Engg II	3	1	0	3	PC
4	CE3009D	Environmental Engg. I	3	1	0	3	PC
5	MS3003D	Economics & Management	3	1	0	3	HL
6		Elective II	3	0	0	3	DE/OE
7	ME3095D	Fluid Mechanics and Fluid Machinery Laboratory	0	0	3	2	PC
8	CE3093D	Computer Applications Laboratory	0	0	3	2	PC
	Total Credits		18	6	6	22	

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1	CE4001D	Environmental Engg. II	3	1	0	3	PC
2	CE4002D	Structural Analysis III	3	0	0	3	PC
3	CE4003D	Water Resource Engineering II	3	0	0	3	PC
4	CE4004D	Construction Management & Quantity Surveying	3	1	0	3	HL
5		Elective III	3	0	0	3	DE/OE
6	CE4091D	Environmental Engg Lab	0	0	3	2	PC
7	CE4092D	Seminar	0	0	2	1	PC
8	CE4098D	Project: Part 1	0	0	6	3	PC
	Total Credits		15	4	11	21	

Semester VIII

Sl. No.	Course Code	Course Title	L	T	P	Credits	Category
1		Elective IV	3	0	0	3	DE/OE
2		Elective V	3	0	0	3	DE/OE
3		Elective VI	3	0	0	3	DE/OE
4	CE4099D	Project: Part 2	0	0	10	5	PC
	Total Credits		9	0	10	14	

Notes:

1. For the successful completion of B.Tech. programme, a student must complete the minimum number of courses of each category specified in the curriculum of the specific programme. In addition to the above, the student must have acquired a total of 160 credits.
2. A student who completes all the course requirements (except the project) before the final semester may be permitted to undertake project at an institute/industry outside with the consent of the department.

MA1001D MATHEMATICS I

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Find the limits, check for the continuity and differentiability of functions of a single variable as well as several variables.

CO2: Test for the convergence of sequences and series of numbers as well as functions.

CO3: Formulate different mensuration problems as multiple integrals and evaluate them.

CO4: Use techniques in vector differential calculus to solve problems related to curvature, surface normal and directional derivative.

CO5: Find the parametric representation of curves and surfaces in space and will be able to evaluate the integral of functions over curves and surfaces.

Module 1: (13 hours)

Real valued function of real variable: Limit, Continuity, Differentiability, Local maxima and local minima, Curve sketching, Mean value theorems, Higher order derivatives, Taylor's theorem, Integration, Area under the curve, Improper integrals.

Function of several variables: Limit, Continuity, Partial derivatives, Partial differentiation of composite functions, Differentiation under the integral sign, Local maxima and local minima, Saddle point, Taylor's theorem, Hessian, Method of Lagrange multipliers.

Module 2: (13 hours)

Numerical sequences, Cauchy sequence, Convergence, Numerical series, Convergence, Tests for convergence, Absolute convergence, Sequence and series of functions, point-wise and uniform convergence, Power series, Radius of convergence, Taylor series.

Double integral, Triple integral, Change of variables, Jacobian, Polar coordinates, Applications of multiple integrals

Module 3: (13 hours)

Parameterised curves in space, Arc length, Tangent and normal vectors, Curvature and torsion, Line integral, Gradient, Directional derivatives, Tangent plane and normal vector, Vector field, Divergence, Curl, Related identities, Scalar potential, Parameterised surface, Surface integral, Applications of surface integral, Integral theorems: Green's Theorem, Stokes' theorem, Gauss' divergence theorem, Applications of vector integrals.

References:

1. H. Anton, I. Bivensand S. Davis, Calculus, 10th edition, New York: John Wiley & Sons, 2015.
2. G. B. Thomas, M.D. Weirand J. Hass, Thomas' Calculus, 12th edition, New Delhi, India: Pearson Education, 2015.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New York: John Wiley & Sons, 2015.
4. Apostol, Calculus Vol. 1, 1st ed. New Delhi: Wiley, 2014.

MA1002D MATHEMATICS II

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes

Students will be able to:
CO1: Test the consistency of system of linear equations and then solve it.
CO2: Test for linear independence of vectors and perform orthogonalisation of basis vectors.
CO3: Diagonalise symmetric matrices and use it to find the nature of quadratic forms.
CO4: Formulate some engineering problems as ODEs and hence solve them.
CO5: Use Laplace transform and its properties to solve differential equations and integral equations.

Module 1: (16 hours)

System of Linear equations, Gauss elimination, Solution by LU decomposition, Determinant, Rank of a matrix, Linear independence, Consistency of linear system, General form of solution.

Vector spaces, Subspaces, Basis and dimension, Linear transformation, Rank-nullity theorem, Inner-product, Orthogonal set, Gram-Schmidt orthogonalisation, Matrix representation of linear transformation, Basis changing rule.

Types of matrices and their properties, Eigenvalue, Eigenvector, Eigenvalue problems, Cayley-Hamiltonian theorem and its applications, Similarity of matrices, Diagonalisation, Quadratic form, Reduction to canonical form.

Module 2: (13 hours)

Ordinary Differential Equations (ODE): Formation of ODE, Existence and uniqueness solution of first order ODE using examples, Methods of solutions of first order ODE, Applications of first order ODE.

Linear ODE: Homogenous equations, Fundamental system of solutions, Wronskian, Solution of second order non-homogeneous ODE with constant coefficients: Method of variation of parameters, Method of undetermined coefficients, Euler-Cauchy equations, Applications to engineering problems, System of linear ODEs with constant coefficients.

Module 3: (10 hours)

Gamma function, Beta function: Properties and evaluation of integrals.

Laplace transform, Necessary condition for existence, General properties, Inverse Laplace transform, Transforms of derivatives and integrals, Differentiation and Integration of transform, Unit-step function, Shifting theorems, Transforms of periodic functions, Convolution, Solution of differential equations and integral equations using Laplace transform.

References:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, New Delhi, India: Wiley, 2015.
2. G. Strang, Introduction to Linear Algebra, Wellesley MA: Cambridge Press, 2016.
3. R. P. Agarwal and D. O 'Regan, An Introduction to Ordinary Differential Equations, New York: Springer, 2008.
4. V. I. Arnold, Ordinary Differential Equations, New York: Springer, 2006.
5. P. Dyke, An Introduction to Laplace Transforms and Fourier Series, New York: Springer,2014.

PH1001D PHYSICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Apply relevant fundamental principles of modern physics to problems in engineering.

CO2: Develop knowledge of basic principles of Quantum Physics

CO3: Acquire knowledge of the basic physics of a collection of particles and the emergent macroscopic properties.

CO4: Apply principles of quantum and statistical physics to understand properties of materials

Module 1: (12 hours)

Particle nature of radiation – Photoelectric effect, Compton effect, Wave nature of matter – matter waves, wave packets description, phase and group velocity, uncertainty principle. Formulation of Schrödinger equation, physical meaning of wave function, expectation values, time-independent Schrödinger equation, quantization of energy for bound particles. Application of time-independent Schrödinger equation to free particle, infinite well, finite well, barrier potential, tunneling.

Module 2: (14 hours)

Simple Harmonic Oscillator, two-dimensional square box, the scanning tunneling microscope. Wave function for two or more particles, indistinguishable particles, symmetry and anti-symmetry under exchange of particles, Pauli's exclusion principle, electronic configurations of atoms. Quantum model of a solid – periodicity of potential and bands, E – k diagram, effective mass, band gap.

Module 3: (13 hours)

Microstates and macrostates of a system, equal probability hypothesis, Boltzman factor and distribution, ideal gas, equipartition of energy, Maxwell speed distribution, average speed, RMS speed, Quantum distributions - Bosons and Fermions, Bose-Einstein and Fermi-Dirac distribution, applications.

References:

1. Kenneth Krane, Modern Physics, 2^{nd} Ed., Wiley (2009)
2. Arthur Beiser, Concepts of Modern Physics, 6^{th} Ed., Tata Mc Graw –Hill Publication (2009)
3. Robert Eisberg and Robert Resnick, Quantum Physics of atoms, Molecules, Solids, Nuclei and Particle, 2^{nd} Ed., John Wiley (2006)
4. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics, 6^{th} Ed., Wiley (2004)

CY1001D CHEMISTRY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Acquire knowledge about separation strategies, identification and characterization of molecules

CO2: Understand the causes and mechanism of corrosion and understand its prevention methods

CO3: Attain knowledge about electrochemical reactions and their current applications

CO4: Comprehend the principles of industrial catalytic processes and enzyme catalysis

Module 1: (14 hours)

Spectroscopy – General Principles, Infrared, group frequencies, Electronic spectroscopy of conjugated molecules, Woodward-Fieser Rule.

Chromatography – Retention and Separation factors, Theoretical plates, Instrumentation and uses of Gas Chromatography and High Performance Liquid Chromatography

Thermal analysis – Thermogravimetry, Differential Scanning Calorimetry and Differential Thermal Analysis

Module 2: (12 hours)

Electrochemical corrosion – Mechanisms, control and prevention.

Cyclic voltammetry, Switching potentials, Cathodic and anodic peak currents Potentiometry, Fuel cells – Types and applications

Liquid crystals – Phase types, uses in displays and thermography.

Module 3: (13 hours)

Catalysis – Homogeneous and heterogeneous catalysis, Organometallic compounds, 18-electron rule, Oxidative addition, Reductive elimination, insertion and Elimination reactions, Wilkinson's catalyst in alkene hydrogenation, Zeigler-Natta catalysis in polymerization of olefins.

Enzyme catalysis – Mechanisms, significance of Michaelis – Menten constant, Turnover number, Co-enzymes and cofactors

References:

1. C. N. Banwell and E. M. McCash, *Fundamentals of Molecular Spectroscopy*, 4th edition, Tata McGraw Hill, New Delhi, 2010.
2. D. A. Skoog and D. M. West, F. J. Holler and S. R. Crouch, *Fundamentals of Analytical Chemistry*, Brooks Cole, Florence, 2004.
3. H. H. Williard, L. L. Merrit, J. A. Dean and F. A. Settle, *Instrumental Methods of Analysis*, Wadsworth Publishing Company, Belmont, California, 1986.
4. B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry,* Vishal Publishing, New Delhi, 2000.
5. J. E. Huheey, E.A. Keiter and R.L. Keiter, *Inorganic Chemistry, Principles of Structure and Reactivity*, 4th Ed, Harper Collins College Publishers, New York, 1993.
6. C. Elschenbroich, *Organometallics*, 3rd edition, Wiley-VCH Verlag GmbH, Weinheim, 2006.

MS1001D PROFESSIONAL COMMUNICATION

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: To distinguish the different types of meaning for constructive criticism, by developing a comprehensive understanding of the extensive vocabulary and usage in formal English language.

CO2: Learn and practice principles related to good formal writing.

CO3: Develop competence in group activities such as group discussions, debates, mock interviews, etc. by practicing the integration of unique qualities of nonverbal and verbal styles.

CO4: Deliver clear and effective presentation of ideas in the oral / written medium and to acquire the ability to modify it according to the target audience.

Module 1: (12 hours)

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations.

Module 2: (15 hours)

Fundamental grammar, Simple structures, passivizing the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open –ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.

Module 3: (12 hours)

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same. Different types of interviews, and presentation-oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates.

References:

1. Duck, Steve and David T. Macmahan. *Communication in Everyday Life*. 3rd Ed. Sage, 2017.
2. Quintanilla, Kelly M. and Shawn T. Wahl. *Business and Professional Communication*. Sage, 2016.
3. Gamble, Kawl Teri and Michael W. Gamble. *The Public Speaking Playbook*. Sage, 2015.
4. Tebeaux, Elizabeth and Sam Dragga. *The Essentials of Technical Communication*, 3rd Ed. OUP, 2015
5. Raman, Meenakshi and Sangeetha Sharma. *Technical Communication: Principles and Practice*, OUP, 2015
6. MacLennan, Jennifer. *Readings for Technical Communication*. OUP, 2007.

ZZ1001D ENGINEERING MECHANICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Determine the resultants of a force system

CO2: Solve rigid body statics problems using equations of equilibrium and principle of virtual work

CO3: Perform kinematic analysis of a particle

CO4: Solve particle dynamics problems using Newton's laws, energy methods and momentum methods

Module 1: (13 hours)

Basic Concepts

Introduction: idealizations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics, elements of vector algebra.

Important vector quantities: position vector, moment of a force about a point, moment of a force about an axis, the couple and couple moment, couple moment as a free vector, moment of a couple about a line.

Equivalent force systems: translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems, reduction of general force system to a wrench.

Module 2: (13 hours)

Statics

Equations of equilibrium: free-body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy.

Applications of equations of equilibrium: Trusses: solution of simple trusses using method of joints and method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems; Cables and chains.

Properties of surfaces: first moment and centroid of plane area, second moments and product of area for a plane area, transfer theorems, rotation of axes, polar moment of area, principal axes.

Method of virtual work: principles of virtual work for rigid bodies and its applications.

Module 3: (13 hours)

Dynamics

Kinematics of a particle: introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations in rectangular coordinates, velocity and acceleration in terms of path variables and cylindrical coordinates, simple kinematical relations and applications.

Dynamics of a particle: introduction, Newton’s law for rectangular coordinates, rectilinear translation, Newton’s law for cylindrical coordinates, Newton’s law for path variables, energy and momentum methods: introduction, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, impulse and momentum relations, moment-of-momentum equation.

References:

1. I. H. Shames, *Engineering Mechanics—Statics and Dynamics*, 4th Edition, Prentice Hall of India, 1996.
2. F.P. Beer and E.R. Johnston, *Vector Mechanics for Engineers – Statics,* McGraw Hill Book Company, 2000.
3. J.L. Meriam and L.G. Kraige, *Engineering Mechanics – Statics*, John Wiley & Sons, 2002.
4. R.C Hibbler, Engineering Mechanics—Statics and Dynamics, 11th Edition, Pearson, India, 2009

ZZ1002D ENGINEERING GRAPHICS

Pre-requisites: Nil

L	T	P	C
2	0	2	3

Total hours: 52

Course Outcomes:

Students will be able to:
CO1: Make use of the Indian Standard Code of Practice in Engineering Drawing.
CO2: Represent any engineering object by its orthographic views.
CO3: Convert orthographic views of an engineering object into its isometric view.
CO4: Enhance the capacity of visualization of engineering objects.

Module 1: (15 hours)

Introduction; drawing instruments and their uses; lines, lettering and dimensioning; geometrical construction; constructions of plain, diagonal and vernier scales; orthographic projection—first and third angle projections; orthographic projection of points on principal, profile, and auxiliary planes.

Module 2: (17 hours)

Orthographic projection of straight line in simple and oblique positions; application of orthographic projection of line; orthographic projection of planes in simple and oblique position on principal and profile planes; orthographic projection of lines and planes on auxiliary planes.

Module 3: (20 hours)

Orthographic projection of solids in simple and oblique positions on principal and profile planes; orthographic projections of solids in oblique position using auxiliary plane method; orthographic projection of spheres; orthographic projection of solids in section; development of surfaces of solids; method of isometric projection.

References:

1. N. D. Bhatt, Engineering Drawing, 53rd ed. Anand, India: Charotar Publishing House, 2016.
2. Basant Agrawal and C M Agrawal, Engineering Drawing, 2nd ed. New Delhi, India: McGraw Hill Education (India), 2014.

ZZ1003D BASIC ELECTRICAL SCIENCES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Design simple resistive circuits for various applications in Electrical and Electronics engineering.

CO2: Design simple magnetic circuits and inductive components for signal and power processing.

CO3: Carry out design verification calculations, power and power loss calculations, voltage drop calculations etc. in single phase ac circuits.

CO4: Analyze Amplifiers and Digital Circuits in terms of critical parameters and complexity.

CO5: Design sub modules for systems/ Solutions for real life problems using suitable sensors /transducers, amplifiers, data converters and digital circuits.

Module 1: (11 hours)

Analysis of Resistive Circuits:

v-i relationship for Independent Voltage and Current Sources

Solution of resistive circuits with independent sources- Node Voltage and Mesh Current Analysis, Nodal Conductance Matrix and Mesh Resistance Matrix and symmetry properties of these matrices

Source Transformation and Star-Delta / Delta-Star Conversions to reduce resistive networks

Circuit Theorems - Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.

Magnetic Circuits:

MMF, Magnetic Flux, Reluctance, Energy stored in a Magnetic Field, Solution of Magnetic Circuits.

Two Terminal Element Relationships:

Inductance - Faraday's Law of Electromagnetic Induction, Lenz's Law, Self and Mutual Inductance, Inductances in Series and Parallel, Mutual Flux and Leakage Flux, Coefficient of Coupling, Dot Convention, Cumulative and Differential Connection of Coupled Coils.

Capacitance – Electrostatics, Capacitance, Parallel Plate Capacitor, Capacitors in series and parallel, Energy stored in Electrostatic Field, v-i relationship for Inductance and Capacitance

Module 2: (9 hours)

Single Phase AC Circuits:

Alternating Quantities - Average Value, Effective Value, Form and Peak factors for square, triangle, trapezoidal and sinusoidal waveforms.

Phasor representation of sinusoidal quantities - phase difference, Addition and subtraction of sinusoids, Symbolic Representation: Cartesian, Polar and Exponential forms.

Analysis of a.c circuits - R, RL, RC, RLC circuits using phasor concept, Concept of impedance, admittance, conductance and susceptance.

Power in single phase circuits - instantaneous power, average power, active power, reactive power, apparent power, power factor, complex power, solution of series, parallel and series parallel a.c circuits.

Module 3 (11 hours)

Sensors and Transducers:

principles of piezoelectric, photoelectric, thermoelectric transducers, thermistors, strain gauge, LVDT, etc, Measurement of temperature, pressure, velocity, flow, pH, liquid level, etc.

Basics of Signal Amplification:

(Explanation based on two port models is only envisaged) – voltage gain, current gain and power gain, amplifier saturation, types of amplifiers (voltage, current, transconductance and transresistance amplifiers) and relationship between these amplifier models, frequency response of amplifiers, single time constant networks.

Operational amplifier basics:

Ideal op-amp, inverting, noninverting, summing and difference amplifiers, integrator, differentiator.

Module 4: (8 hours)

Digital Electronics:
Review of number systems and Boolean algebra, Logic Gates and Truth Tables, Simplification of Boolean functions using Karnaugh map (upto 4 variable K-maps), Implementation of Simple combinational circuits (Adder, Code Converters, 7-Segment Drivers, Comparators, Priority Encoders, etc) - MUX-based implementation of combinatorial circuits , Sequential circuits: SR,JK, T and D filpflops, counters and registers using D flip flops, Basics of data converters (at least one ADC and DAC).

References:

1. J.W. Nilsson and S.A. Riedel, *Electric Circuits*, 8th ed., Pearson, 2002
2. K.S. Suresh Kumar, *Electric Circuits & Networks*, Pearson Education, 2009
3. C. A. Desoer and E. S. Kuh, *Basic Circuit Theory*, McGraw Hill, 2009
4. J. A. Edminister, *Electric Circuit Theory*, Schaum's Outline series: 6th ed., McGraw Hill, 2014
5. A. D. Helfrick and W. D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India, 2003
6. A. S. Sedra and K. C. Smith, *Microelectronics*, 6thed.,Oxford University Press, 2013
7. C. H. Roth and L. L. Kinney, *Fundamentals of Logic Design*,7thed., Cengage Learning,2014

ZZ1004D COMPUTER PROGRAMMING

Pre-requisites: Nil.

L	T	P	C
2	0	0	2

Total hours: 26

Course Outcomes:

Students will be able to:
CO1: Design of algorithms for simple computational problems.
CO2: Express algorithmic solutions in the C programming language.

Module 1: (10 hours)

Data Types, Operators and Expressions: Variables and constants - declarations - arithmetic and logical operators – Assignment operator – Input/Output.

Control Flow: Statements and blocks – if-else, switch, while, for and do-while statements – break and continue – goto and labels.

Module 2: (08 hours)

Functions and Program structure: Basics of functions, Parameter passing – scope rules – recursion.

Module 3: (08 hours)

Aggregate data types: Single and multidimensional arrays, structures and unions – Pointers to arrays and structures – passing arrays and pointers as arguments to functions.

References:

1. B.S. Gottfried, *Programming with C (Schaum's Outline Series)*, 2nd ed. McGraw-Hill,1996.
2. B. W. Kernighan and D. M. Ritchie, *The C Programming Language*, 2nd ed. Prentice Hall, 1988.
3. W. Kernighan, *The Practice of Programming*, Addison-Wesley, 1999.

PH1091D PHYSICS LAB

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 26

Course Outcomes:

Students will be able to:

CO1: To develop experimentation skills and understand importance of measurement practices in Science & Technology.

CO2: Develop analytical skills for interpreting data and drawing inferences.

CO3: Estimate the nature of experimental errors and practical means to obtain errors in acquired data.

CO4: Develop skills for team work and technical communication and discussions.

CO5: Apply theoretical principles of modern physics to analysis and measurements performed in the laboratory.

List of Experiments:

1. Magnetic Hysteresis loss - Using CRO
2. Band gap using four probe method
3. Hall effect- determination of carrier density, Hall coefficient and mobility
4. Solar cell characteristics
5. Double refraction – measurement of principle refractive indices.
6. Measurement of N.A & Attenuation
7. Measurement of e/m of electron – Thomson's experiment
8. Determination of Planck's constant
9. Measurement of electron charge – Millikan oil drop experiment
10. Determination of magnetic field along the axis of the coil
11. Newton's rings
12. Laurent's Half shade polarimeter –determination of specific rotatory power
13. Study of P-N junction
14. Study of voltage-current characteristics of a Zener diode.
15. Laser – measurement of angle of divergence & determination of λ using grating
16. Measurement of magnetic susceptibility- Quincke's Method / Gouy's balance.
17. Mapping of magnetic field
18. Temperature measurement by using thermocouple

NOTE: Any 8 experiments have to be done.

References:

1. A.C. Melissinos, J. Napolitano, Experiments in Modern Physics, Academic Press (2003)
2. Avadhanulu, Dani and Pokley, Experiments in Engineering physics, S. Chand & Company ltd (2002).
3. S.L. Gupta and V. Kumar, Practical physics, Pragathi Prakash (2005)

CY1094D CHEMISTRY LAB

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 26

Course Outcomes:

Students will be able to:
CO1: Acquire practical knowledge on the separation of mixtures and their identification
CO2: Understand chirality and the specific rotation of a compound
CO3: Attain practical experience in the synthesis of new molecules
CO4: Apply different techniques to quantitatively determine the amount of components

List of Experiments:

1. Determination of specific rotation by polarimetry
2. Potentiometric titrations
3. Estimation of ions using complexometry
4. Determination of strength of an acid using pH meter
5. Analysis of organic and inorganic compounds
6. Conductometric titrations using acid or mixture of acids
7. Separation of compounds using chromatography
8. Colorimetric estimations
9. Determine the eutectic temperature and composition of a solid two component system
10. Synthesis of organic/inorganic compounds and their characterizations
11. Determination of molecular weight of polymers

Note: Selected experiments from the above list will be conducted

References:

1. G. H. Jeffery, J. Bassett, J. Mendham and R.C. Denny, *Vogel's Text Book of Quantitative Chemical Analysis*, Longmann Scientific and Technical, John Wiley, New York,1989.
2. A. I. Vogel, *Elementary Practical Organic Chemistry – Small Scale Preparations*, Pearson India, New Delhi, 2011.
3. A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hannaford and P. W. G. Smith, *Vogel's Text Book of Practical Organic Chemistr*y, Longman and Scientific Technical, New York, 1989.

ZZ1091D WORKSHOP I

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Perform experiments to ascertain the quality requirements and quality testing procedures of selected building material, viz., cement, fine aggregate, coarse aggregate, concrete, timber and steel.

CO2: Identify and evaluate various driver characteristics as driver of a vehicle.

CO3: Acquire knowledge about basic civil engineering practices of brick masonry, plumbing and surveying.

CO4: Perform wiring estimation and costing for simple building/commercial electrical wiring systems.

CO5: Use commonly employed wiring tools and lighting and wiring accessories.

CO6: Adopt electrical safety measures in using and servicing household appliances.

Civil Engineering Workshop: (24 hours)

1. Introduction to Surveying – Linear measurements – Hands on session on Setting out of a small residential building.
2. Introduction to Levelling – Hands on sessions using Dumpy level – Levelling exercise.
3. Introduction to Total Station – Hands on sessions - small exercises.
4. Tests on cement and aggregates: Demonstration of standard consistency, initial and final setting time of cement - Hands on sessions - Compressive strength test on cement mortar cubes and sieve analysis for coarse and fine aggregates.
5. Tests on hardened concrete, brick, timber and steel: Demonstrations on hardness tests (Rockwell hardness), impact tests (Charpy and Izod) on steel specimens-demonstration on properties of timber – Hands on sessions - Compression test on concrete cubes, bricks and tension test on mild steel specimen.
6. Masonry: Hands on sessions - English bond, Flemish bond – wall junction – one brick – one and a half brick - Arch construction.
7. Water supply and sanitation: Study of water supply pipe fittings – tap connections – sanitary fittings
8. Various tests on Driver characteristics – Visual acuity and colour blindness, peripheral vision, depth perception, driver reaction time.

Electrical Engineering Workshop: (15 hours)

1. (a) Familiarization of wiring tools, lighting and wiring accessories, various types of wiring systems.

   (b) Wiring of one lamp controlled by one switch.
2. (a) Study of Electric shock phenomenon, precautions, preventions, Earthing.

   (b) Wiring of one lamp controlled by two SPDT Switches and one 3 pin plug socket independently.
3. (a) Familiarization of various types of Fuses, MCBs, ELCBs, etc.

   (b) Wiring of fluorescent lamp controlled by one switch with ELCB & MCB.
4. (a) Study of estimation and costing of wiring.

   (b) Wiring, control and maintenance of domestic appliances like Mixer machine, Electric Iron, fan, motor, etc.

References:

1. T.P. Kanetkar, S.V. Kulkarni, *Surveying and Levelling - Part1*, Pune Vidyarthi Griha Prakashan, Pune, 1994.
2. B.C. Punmia, *Building Construction*, Laxmi Publications, New Delhi1999.
3. Satheesh Gopi, R. Sathikumar, N. Madh, *Advnaced Surveying*, Pearson Education,2007.
4. M.S. Shetty, *Concrete Technology*, S. Chand & Company, New Delhi,2005.
5. K. B. Raina & S. K. Bhattacharya, *Electrical Design Estimating and costing*, New Age International Publishers, New Delhi, 2005.
6. Khanna, S. K., and Justo, C. E. G., *Highway Engineering*, Nemchand and Bros, Roorkee,2001.
7. Uppal S. L., *Electrical Wiring & Estimating*, Khanna Publishers---5th edition, 2003.
8. John H. Watt, *Terrell Croft American Electricians' Handbook: A Reference Book for the Practical Electrical Man*, 9th ed. McGraw-Hill, 2002.

ZZ1092D WORKSHOP II

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Select suitable material for a given purpose applying knowledge of material properties and processing.

CO2: Use measuring devices like Vernier Calipers, Micrometers, etc.

CO3: Fabricate simple components using basic manufacturing processes like Casting, Forming, Joining and Machining.

CO4: Sequence various operations so as to execute the task within minimum time.

CO5: Perform diagnostic measurements using analog and digital meters for troubleshooting electronic systems.

CO6: Select appropriate electronic components for a given design task and assemble the prototype on breadboard.

CO7: Troubleshoot electronic boards used in various household appliances.

CO8: Perform cost estimation and costing of PCB soldering and carry out the soldering.

Mechanical Engineering Workshop: (24 hours)

The course is intended to expose the student to various manufacturing processes through hands on training in different sections of Central Workshop. During the course, the student learns the properties and selection of different materials and acquires the skill in using various tools and measuring devices.

1. Carpentry: Study of tools and joints – plaining, chiseling, marking and sawing practice, one typical joint- Tee halving/Mortise and Tenon/ Dovetail
2. Fitting: Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints. Edge preparation for single V joint.
3. Welding: Study of arc and gas welding, accessories, joint preparation. Welding of a single V joint
4. Smithy: Study of tools. Forging of square or hexagonal prism/chisel/bolt
5. Foundry: Study of tools, sand preparation. Moulding practice using the given pattern.
6. Sheet Metal: Study of tools, selection of different gauge sheets, types of joints. Fabrication of a tray or a funnel
7. Machine Shop: Study of the basic lathe operations. Simple step turning exercise.

Electronics Engineering Workshop: (15 hours)

1. (a) Familiarization of electronic components, colour code, multimeters.
   (b) Bread board assembling-Common emitter amplifier.
2. (a) Study of soldering components, solders, tools, heat sink.
   (b) Bread board assembling-phase shift oscillator.
3. (a) Soldering practice-Common emitter amplifier.
   (b) Soldering practice-Inverting amplifier circuit.
4. (a) Study of estimation and costing of soldering PCB, 3 phase connections.
   (b) PCB wiring and fault Identification of appliances like Electronic Ballast, fan regulator, inverter, UPS, etc.

References:

1. W. A. J. Chapman, Workshop Technology - Parts 1 & 2, 4th ed. New Delhi, India, CBS Publishers & Distributors Pvt. Ltd., 2007.

2. Welding Handbook. 9th ed. Miami, American Welding Society, 2001.
3. J. Anderson, Shop Theory, New Delhi, India, Tata McGraw Hill, 2002.
4. J. H. Douglass, Wood Working with Machines, Illinois, McKnight & McKnight Pub. Co., 1995.
5. W.A. Tuplin, Modern Engineering Workshop Practice, Odhams Press, 1996.
6. P. L. Jain, Principles of Foundry Technology, 5th ed. New Delhi, India, Tata McGraw Hill, 2009.
7. John H. Watt, Terrell Croft, American Electricians' Handbook: A Reference Book for the Practical Electrical Man, 9th ed. McGraw-Hill, 2002.
8. G. Randy Slone, Tab Electronics Guide to Understanding Electricity and Electronics, 2nd ed. McGraw-Hill, 2000.
9. Jerry C Whitaker, The Resource Handbook of Electronics, CRC Press-2001.

ZZ1093D PHYSICAL EDUCATION

Pre-requisites: Nil

L	T	P	C
1	0	1	1

Total hours: 26 (13 L +13 P)

Course Outcomes:

CO1: Select a game/ activity of his/ her choice to pursue on the campus to enjoy/ entertain and thereby develop good health and fitness which he/she would carry over to post-campus life for maintaining health, fitness and wellness.

CO2: Be more proficient in a game, which may lead him/her to a berth in the institute teams.

CO3: Gain exposure to professional training, so as to enable him / her to excel in sports activities.

CO4: Participate in intramural and open mass participation activities.

CO5: Participate and organise in-campus or off-campus sports activities.

UNIT – I - Introduction, definition, aims & objectives of Physical Education. Health, Physical fitness and wellness. Importance, scope and relevance of Physical Education in NITC curriculum.

UNIT – II - Physical fitness and components. Health related Physical fitness and components. Benefits of exercise – physical and physiological.

UNIT – III - Physical exercise and its principles. Activities for developing physical fitness – walking, jogging, running, weight training, stretching, yogasanas. Athletic injuries and their management. Nutritional balance.

UNIT – IV - Motivation and its importance in sports. Stress, anxiety, tension, aggression in sports. Personality, self-confidence and performance. Team cohesion and leadership in sports.

UNIT – V - Lifestyle diseases and its management, Diabetes and Obesity, Hypertension, Osteoporosis
Coronary heart diseases and cholesterol. Backpain, Postural deformities and their remedies.

UNIT – VI. - Olympic Values Education. Event & Crisis management.

References

1. Najeeb, A. M., Atul, M., Sumesh, D. and Akhilesh, E. *Fitness Capsule for university curriculum*, 2015

ZZ1094D VALUE EDUCATION

L	T	P	C
1	0	1	1

Total hours: 39

Course Outcomes

1. Identify the purpose of education and the problems faced by mankind, in terms of socio economic and environmental issues.
2. Describe the social and intellectual needs to transform the society to a better one where everyone meets the basic economic and social security, freedom and atmosphere to live a meaningful life.
3. Practise a meaningful life avoiding all kinds of corrupt practices and develop unconditional love, universal brotherhood and simulate international peace and prosperity.
4. Persuade others to practise a righteous life, which would stimulate a synergy of universal harmony and peace.
5. Create an ideal society where everyone enjoys the fruits of love, peace and harmony.

Unit I (2 hours): **Social Justice** Definition –need-parameters of social justice –factors responsible for social injustice –caste and gender –contributions of social reformers.

Unit II (3 hours)**: Human Rights and Marginalized People** Concept of Human Rights-Principles of human rights-human rights and Indian Constitution-Rights of Women and children-violence against women –Rights of marginalized People-like women, children, dalits, minorities, physically challenged etc.

Unit III (3 hours): **Social Issues and Communal Harmony** Social issues–causes and magnitude-alcoholism, drug addiction, poverty, unemployment etc.-communal harmony-concept-religion and its place in public in public domain-separation of religion from politics-secularism role of civil society.

Unit IV (3 hours): **Media Education and Globalized World Scenario** Mass media-functions-characteristics-need and purpose of media literacy-effects and influence –youth and children-media power-socio cultural and political consequences mass mediated culture-consumerist culture-Globalization-new media –prospects and challenges-Environmental ethics

Unit V (2 hours): **Values and Ethics** Personal values –family values-social values-cultural values-professional values-and overall ethics-duties and responsibilities

Project: 10 hours

References

1. Sharma, B. K. (2010), 'Human Rights Covenants and Indian Law', PHI Learning Pvt. Ltd.
2. Law Commission of India, (1971), 'Indian Penal code', (http://lawcommissionofindia.nic.in/1-50/report42.pdf), accessed on February 14, 2018.
3. Srivastava, S. S. (2017), 'Central Law Agency's Indian Penal Code along with General Principles (IPC)', Central Law Agency.
4. 'Gandhiji on Communal Harmony', (2003), Mani Bhavan Gandhi Sangrahalaya', Mumbai.
5. 'Social Impact of Drug Abuse', UNDCP, ((https://www.unodc.org/pdf/technical_series_1995-03-01_1.pdf, accessed on February 14, 2018).
6. Bryfonski, D. (2012), 'The Global Impact of Social Media', Green Heaven Publications**.**
7. Schmidtz, D. &Willott, E. (2012), 'Environmental Ethics: What Really Matters, What Really Works', Oxford University Press.
8. Ranganathanda, S. (1987), 'Eternal Values for a Changing Society: Education for human excellence', BharatiyaVidyaBhavan.
9. Rokeach, M. (1979), 'Understanding human values: Individual and Societal', The New Free Press.

ZZ1095D NSS

L	T	P	C
0	0	3	1

Total hours: 39

Course Outcomes

CO1: Acquire awareness in social and environmental issues thereby improving social consciousness and commitment towards the community.

CO2: Participate in socially relevant activities that are aimed at betterment of the campus and the society, thereby instilling a helpful attitude

CO3: Develop a positive attitude towards dignity of labour, self-help and the need for combining physical work with intellectual pursuits.

CO4: Improve inter-personal skills and contribute to nation building by serving the local community, thereby promoting a healthy and positive attitude towards life.

NSS activities have been divided in two major groups. These are Regular NSS Activities and Special Camping programme.

(a) Regular NSS Activity: NSS volunteers undertake various activities in adopted villages and slums for community service. The NSS units organise the regular activities as detailed below:

i) Orientation of NSS volunteers: To get the NSS volunteers acquainted with the basics of NSS programmes, for their orientation through lectures, discussions, field visits, audio-visuals etc.

ii) Campus Work: The NSS volunteers may be involved in the projects undertaken for the benefit of the institution and students concerned. Such projects cover maintenance of public properties, tree plantation, waste management and Swach Bharat activities, conservation of water and energy sources, social audits, awareness programmes on drug-abuse, AIDS, population education, and other projects

iii) Community service will be in adopted villages/urban slums independently or in collaboration with others in this field.

iv) Institutional work: The students may be placed with selected voluntary organisations working for the welfare of women, children, aged and disabled outside the campus.

v) Rural Project: The rural projects generally include the working of NSS volunteers in adopted villages for e-governance and digital literacy, watershed management and wasteland development, rainwater harvesting, agricultural operations, health, nutrition, hygiene, sanitation, mother and child care, gender equality sensitization programmes, family life education, gender justice, development of rural cooperatives, savings drives, construction of rural roads, campaign against social evils etc.

vi) Urban Projects: In addition to rural projects other include adult education, welfare of slum dwellers, work in hospitals, orphanages, destitute home, environment enrichment, population education, drug, AIDS awareness, and income generation,

vii) National Days and Celebrations: The National Service Scheme programmes also include the celebration of National days. The purpose of such a provision is to celebrate such occasions in a befitting manner,

viii) Blood Donation Activities,

ix) Campus farming activities,

x) Activities for social inclusion such as organizing programmes for differently – abled children.

Students shall volunteer and contribute to the activities of the National Service Scheme for a minimum duration of 39 hours for the award of credit.

b) Special Camping Programme: Under this, camps of 7 days' duration are organised during vacations with some specific projects by involving local communities.

MA2001D MATHEMATICS III

Pre-requisites: Nil

Total hours: 39

L	T	P	C
3	1	0	3

Course Outcomes:

Students will be able to:

CO1: Handle application problems involving random variables and functions of random variables.

CO2: Identify statistical problems and make use of statistical inference while handling stochastic systems.

CO3: Apply regression and correlation analysis for studying relationship between variables.

CO4: Identify situations where analysis of variance is appropriate and apply it.

CO5: Use probabilistic and statistical analysis in various applications of engineering.

Module 1: (15 hours)

Probability distributions, Random variables, Expectation of a function of a random variable, Mean, Variance and Moment generating function of a probability distribution, Chebyshev's theorem, Binomial distribution, Poisson distribution, Geometric distribution, Hyper- geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution and Weibull distribution. Transformation of a random variable, Probability distribution of a function of a random variable, Jointly distributed random variables, Marginal and conditional distributions, Bi-variate Normal distribution, Joint probability distribution of functions of random variables**.**

Module 2: (14 hours)

Population and samples, The sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Point estimation, Maximum likelihood estimation, Method of moments,Interval estimation, Point estimation and interval estimation of mean and variance. Tests of hypothesis, Hypothesis tests concerning one mean and two means. Hypothesis tests concerning one variance and two variances, Estimation of proportions, Hypothesis tests concerning one proportion and several proportions, Analysis of $r \times c$ contingency tables, Chi – square test for goodness of fit.

Module 3: (10 hours)

Analysis of variance, General principles, Completely randomized designs, Randomized block design. Curve fitting, Method of least squares, Estimation of simple regression models and hypotheses concerning regression coefficients, Correlation coefficient- Estimation of correlation coefficient, Hypothesis concerning correlation coefficient. Estimation of curvilinear regression models.

References:

1. R. A. Johnson, Miller and Freund's Probability and Statistics for Engineers, 8th edition., PHI, New Delhi, 2011.
2. W. W. Hines, D. C. Montgomery, D. M. Goldsman and C. M. Borror, Probability and Statistics in Engineering, 4th edition, John Wiley & Sons, Inc., 2003
3. S.M. Ross, Introduction to Probability and statistics for Engineers and Scientists, 5rd edition, Academic Press (Elsevier), New Delhi, 2014.

CE2001D MECHANICS OF SOLIDS

Pre-requisites: ZZ1001D Engineering Mechanics

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Provide quick / ad-hoc solutions to elementary problems of strength of materials

CO2: Develop elementary skills of working stress design

CO3: Acquire all necessary fundamentals needed for pursuing courses on Structural Analysis and Structural Design

CO4: Apply the appropriate method for finding the deformation/deflections of beams under different loading

CO5: Develop the ability to check the serviceability conditions of the structure in terms of deflection

Module 1 (13 hours)

Tension, compression and shear Types of external loads - self weight - internal stresses - normal and shear stresses - strain - Hooke‘s law - Poisson‘s ratio - relationship between elastic constants - stress strain diagrams - working stress - elongation of bars of constant and varying sections - statically indeterminate problems in tension and compression - assembly and thermal stresses - strain energy in tension, compression and shear.

Bending moment and shear force: Types of beams - shear force and bending moment diagrams for simply supported, overhanging and cantilever beams - relationship between intensity of loading, shear force and bending moment. - stresses in laterally loaded symmetrical beams

Module 2 (14 hours)

Theory of simple bending: limitations - bending stresses in beams of different cross sections - moment of resistance - beams of two materials - shearing stresses in bending - principal stresses in bending - strain energy in bending

Torsion: Torsion of circular solid and hollow shafts - strain energy in shear and torsion – open and close coiled helical springs.

Concept of shear flow and shear center.

Analysis of stress and strain : Stress on inclined planes for axial and biaxial stress fields - principal stresses - Mohr’s circle of stress - principal stress problem as an eigenvalue problem - principal strains - strain rosette -thin cylinders (as an example to biaxial stresses)

Module 3 (12 hours)

Deflection of beams: Differential equation of elastic curve - slope and deflection of beams by successive integration - Macaulay‘s method - moment area method - conjugate beam method - deflection due to shear.

References:

1. Gere, J.M., Mechanics of Materials, Thomson, Singapore, 2001.
2. Timoshenko, S.P., Young, D.H., Elements of Strength of Materials, East West Press, New Delhi, 2003.
3. Popov, E.P., Mechanics of Materials, Prentice Hall India, New Delhi, 2002.
4. Beer, F. P. and Johnston, E. R., Mechanics of Materials, Tata McGraw Hill, New Delhi, 2005
5. Nash, W.A., Strength of Materials, Schaum’s Outline Series, McGraw Hill, New York, 1988.

CE2002D MECHANICS OF FLUIDS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Estimate hydrostatic forces on structures.

CO2: Estimate forces due to fluid-structure interaction.

CO3: Determine discharges in closed conduits and open channels.

CO4: Design and analyze piping systems and pipe-networks.

CO5: Plan experimental studies in fluid mechanics using the principles of similitude.

CO6: Formulate necessary equations required for solution of fluid flow problems.

Module 1: (13 hours)

Fluids: Definition,types, and properties. Viscosity.Fluid as a continuum. System and control volume concepts. Fluid Statics: Fluid pressure, measurement of pressure. Fundamental equation of fluid statics.Hydrostatic forces on immersed surfaces. Application of fluid pressure analysis in engineering problems. Buoyancy and stability of immersed and floating bodies. Pressure in case of accelerated rigid body motion.

Module 2: (13 hours)

Fluid kinematics: Methods of describing fluid motion. Types of fluid motion. Inviscid flows.Velocity and acceleration. Rotational and irrotational flows.Reynolds transport equation. Continuity equation.Potential flows. Velocity potential and Stream function. Cauchy-Reimann equations.Flownet.Circulation and vorticity.

Fluid dynamics: Types of forces, Forces influencing fluid motion. Energy and Head.Energy correction factor, Euler and Bernoulli's equations. Application of Bernoulli's equation. Flow measurement. Linear momentum equation.Momentum correction factor.Applications of momentum equation.

Module 3: (13 hours)

Pipe flow: Introduction. Laminar and turbulent flows.Reynolds‘ number.Head loss - Major loss in pipe flow.Friction loss.Hagen-Poiseulle and Darcy-Weisbach equations.Minor losses.Moody's diagram. Total energy and hydraulic gradient lines.Compound pipes.Pipes in series and parallel.Branching pipes.Pipe networks.Hardy-Cross method.

Introduction to boundary layer theory: Boundary layer growth in flow over a plate. Flow past immersed bodies.

Dimensional analysis and similitude: Methods of dimensional analysis, Dimensionless numbers. Principles of similarity.Modelling using Reynolds and Froude model laws.Distorted models and scale effects.

References:

1. Shames, I.H., Mechanics of Fluids, McGraw Hill ,New York, 1992
2. Streeter, V.L., and Wylie, E.B., Fluid Mechanics, McGraw Hill , New York,1985.
3. Massey, B.S., John Ward Smith, Nelson Thornes Ltd, UK, 2001
4. Subramanya, K., Theory and Applications of Fluid Mechanics, , McGraw Hill , New York,.1992.
5. Modi, P.N.,and Seth, S.M., Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 2005.

CE2003D BUILDING TECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Identify various tests that are required for the quality assurance of materials in construction projects

CO2: Suggest/plan various construction methods for different building elements.

CO3: Understand various advanced topics in building materials and construction.

Module 1 (13 hours)

Bricks- manufacture, properties, testing, types and classification; Tiles - properties and uses -; Lime- Classification, properties and uses; Plastics – properties, uses; Light roofing materials; Glass- manufacture, testing; Geo-synthetics - classification; Timber – seasoning and preservation, Industrial timber products – manufacture and properties; Cement – manufacture, types of cement, properties and testing; Sand - properties; Mortar- types of mortar and uses.

Module 2 (11 hours)

Concrete- Properties of fresh and hardened concrete, test methods, proportioning of concrete mixes; Concrete construction - batching, mixing, placing, compacting and curing of concrete, form work; Precast concrete and pre-stressed concrete; Recent developments in concreting; Iron and steel - Structural sections, properties and uses of structural steel; Recent developments in steel and concrete.

Module 3 (15 hours)

Foundation - timbering of foundation trenches , bearing capacity of soils, improvement of bearing capacity , settlement of foundation ; Description of spread, grillage, raft and pile foundations; Brick and stone masonry - Bonds in brick work ; Cavity walls ; Lintels and arches; Partition walls ; Floors and roofs- different types – flooring and roofing materials ; Doors, windows and ventilators - Different types ; Building Failures - types of failures ,causes and remedial measures ; Building repairs - Shoring , underpinning and scaffolding ; Framed structure- Steel and concrete frames; Joints ; Slip form and lift slab constructions, Fire proof construction - fire load , fire resisting properties of building materials, fire extinguishing methods, fire proof construction methods; Damp proof construction.

References:

1. Rangwala, S. C., Engineering Materials, Charotar Publishing House, 1992.
2. Punmia, B. C., Building Construction, Laxmi Publications, New Delhi,1999.
3. Rangwala, S. C., Building Construction, Charotar Publishing House, 1992.
4. Huntington, W.C., Building Construction, John Wiley, New York,1959.
5. Shetty, M. S., Concrete Technology, S.Chand& Co., New Delhi, 1992.
6. Varghese, P C., Building Materials Prentice Hall of India, 2006.

CE2004D SURVEYING

Pre-requisites: Nil

L	T	P	C
4	0	0	4

Total hours: 52

Course Outcomes:

Student will be able to:

CO1: Carry out field surveys for location, design and construction of engineering projects.
CO2: Adopt suitable survey technique and select equipments based on the required level of accuracy and prevailing field conditions.
CO3: Carry out profiling and grid levelling, for generation of profiles, contour maps for earth works computations.
CO4: Work effectively with modern surveying equipment to improve quality of surveys.
CO5: Analyze and synthesize survey data.

Module 1: (16 hours)

Surveying - Basic Concepts

Surveying definition - principles of surveying - plane surveying - geodetic surveying – Types of errors

Distance Measurement

Measurement methods (Tape, Tacheometry, EDM) - Taping Equipments - Taping on smooth level ground and sloping ground – Ranging - Systematic errors in taping and corrections (Tape standardization, Temperature, Tension, Sag, Slope and Alignment) – Electronic Distance Measurement – Principle of EDMs – Systematic errors and accuracy of EDM systems

Vertical Control

Levelling - Definitions (Level line, Horizontal line, Datum, Bench mark, Reduced Level) – Curvature and refraction – Methods for establishing vertical control – Direct levelling – Instrument types – Principle of levelling- Methods of Booking (Height of collimation, Rise and fall) - Differential levelling – Reciprocal levelling - Errors in levelling – Applications of levelling (profile levelling and contouring)

Module 2: (18 hours)

Angle and Direction Measurement

Definitions (True meridian, Magnetic meridian, Bearings, Azimuths, Interior angles, Deflection angles) – Methods of determining angles and directions (Magnetic compass, Theodolite, Total station) – Prismatic compass – WCB system – Magnetic declination – Local attraction

Transit theodolite – Reading systems (Direct reading or Vernier, optical micrometer, electro-optical) - Temporary adjustments - Measurement of horizontal angles - Method of repetition and reiteration - Measurement of vertical angles – Prolonging a straight line- Prolonging a line past an obstacle- Running a straight line between two points – Instrumental errors – Personal and natural errors

Traversing

Traverse – Traverse stations – Types of traverse – Closed traverse computations and adjustments

Combined Distance and Angular measurement

Tacheometric surveying - Stadia method – Stadia constants – Elevation difference - Staff held normal and vertical - Subtense bar - Tangential tacheometry – Trignometric levelling

Total station systems - Features and functions - applications

Module 3: (18 hours)

Route surveying - Curves

Curves - Types - Elements of a curve - Simple curves - Setting out of curves using various methods – Geometry of compound curves and reverse curves – Introduction to transition and vertical curves

Photogrammetry and Remote Sensing

Aerial Photogrammetry – Basic concepts – Vertical photographs – Scale and Flying height

Remote sensing – Energy sources and radiation principles – Energy interactions in the atmosphere, Energy interactions with earth surface features - Elements of image interpretation

GIS and GNSS

GIS basics - Maps – scale - coordinate system – GIS definition – Components of GIS – Spatial, Non-spatial and metadata - Types of spatial data - Raster and vector data formats – GNSS (GPS, GLONASS) – SBAS (GAGAN)

References:

1. James Anderson and Edward Mikhail, Surveying: Theory and Practice, McGraw Hill Education; 7th edition, 2017
2. Schofield W and M Breach, Engineering Surveying, Elsevier, CBSPD, 6th edition, 2007
3. Subramanian R., Surveying and Levelling, Oxford University Press, 2nd edition, 2012
4. Thomas. M. Lillesand, Ralph. W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation , John Wiley and Sons, Inc., 6th edition, 2011
5. Manoj K. Arora and R.C. Badjatia, Geomatics Engineering, Nem Chand publishers, 1st edition, 2011
6. Lo C. P and K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Pearson Education, 2nd edition, 2016
7. Satheesh Gopi, R.Sathikumar, N. Madhu, Advanced Surveying: Total Station, GPS, GIS & Remote Sensing, Pearson Education, 2nd edition, 2017

CE2005D ENGINEERING GEOLOGY

Pre-requisites: Nil

L	T	P	C
2	1	0	2

Total hours: 26

Course Outcomes:

Students will be able to:

CO1: Acquire knowledge in essential Engineering Geology aspects in Civil Engineering and natural hazards.

CO2: Familiarize with applications of engineering geology for construction of mega Civil engineering structures and Urban/Rural Planning & Development.

Module 1: (8 hours)

History of Earth and Geological Time, Plate Tectonics, Geological formations in India, Rock-forming Minerals, Clay minerals, formation and description of igneous, sedimentary and metamorphic rocks. Weathering of rocks (physical and chemical) and its impact on geomorphology.

Module 2: (8 hours)

Rock structures their description (joints, folds, faults and unconformities).

Groundwater, its sources, movement in rocks, extraction, exploration and recharge.Rainwater harvesting.Geological actions of Rivers, sea and wind and their deposits.Peat, Marshes and Bog.Studies on laterites, Black Cotton Soil, Murrum, Charnockite, Khondalite and Kankar.

Module 3: (10 hours)

Landslides, Rockslides, Rock falls, mud flows and Land subsidence.Improving stability of Earth and Rock slopes.Geological investigations for Reservoirs and Dams, Roads, Railways, bridges and tunneling.Earthquakes, Causes, Measurements and effects on Civil Engineering structures Preparation of Geological Maps, Geophysical Exploration.Geology and subsoil conditions in various parts of India.

References:

1. Varghese,P.C., Engineering Geology for Civil Engineers, PHI Learning Private Limited, Delhi-11092,2015.
2. Bell, F. G., Engineering Geology, Elsevier, India, 2007.
3. Blyth, F.G.H., and De Freitas, M.H., A Geology for Engineers, Elsevier, India, 2007.
4. Parriaux, A., Geology Basics for Engineers, CRC Press, The Netherlands, 2009.
5. Singh, P., Engineering and General Geology, S. K. Kataria and Sons, India, 2013.

CE2091D SURVEYING PRACTICAL

Pre-requisites: CE2004D Surveying or its concurrent registration

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

Student will be able to:

CO1: Use the surveying equipments to carryout field surveys for location, design and construction of engineering projects.

CO2: Analyze and synthesize survey data from the field notes.

CO3: Work effectively as a member of a survey party in completing the assigned field work

List of Exercises:

1. Distance measurement – using Chain and Tape
2. Distance measurement – using Total Station
3. Vertical control – Differential levelling using Dumpy level
4. Vertical control – Check levelling using Dumpy level
5. Measurement horizontal and vertical angles – using Vernier theodolite
6. Measurement horizontal and vertical angles – using Micro-optic theodolite
7. Tacheometric surveying – Stadia method – Determination of heights and distances using Micro-optic theodolite
8. Curve setting – Simple curves using Micro-optic theodolite
9. Traversing – using Total station
10. Contour surveying – Determination of coordinates using total station and preparation of contour map using QGIS

References:

1. James Anderson and Edward Mikhail, Surveying: Theory and Practice, McGraw Hill Education; 7th edition, 2017
2. Schofield W and M Breach, Engineering Surveying, Elsevier, CBSPD, 6th edition, 2007
3. Subramanian R., Surveying and Levelling, Oxford University Press, 2nd edition, 2012
4. Kanetkar T.P., S.V. Kulkarni, Surveying and Levelling - Part1, Pune Vidyarthi Griha Prakashan, Pune, 1994.

CE2092D MATERIAL TESTING LABORATORY I

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Integrate the hands on experience on material testing with their theoretical understanding of mechanical behaviour of materials

CO2: Prepare reports and present the results based on the test data complying to the codes/regulations

CO3: Refer codes and other reference materials for standard property data.

CO4: Interpret the results and recommend the suitability of a material for a given load case.

List of Exercises:

1. Tests on aggregate for concrete
   (a) Grain size distribution (b) Specific gravity (c) Density (d) Voids (e) Bulking
   (f) Aggregate crushing value (g) Aggregate impact value
2. Tests on cement
   (a) Fineness (b) Normal consistency (c) Setting time (d) Compressive strength
3. Test on Timber beam – Bending test
4. Tests on tiles – Dimension, Transverse Strength, Water Absorption and Crazing
5. Tests on bricks – Crushing strength, water absorption and efflorescence
6. Tests on metals – Hardness test and impact test

References:

1. Neville, A. M., Properties of Concrete, Pitman, 1987.
2. Shetty, M. S., Concrete Technology, S I Chand and Company, 1993.
3. Timoshenko, S.P., Strength of materials, CBS publishers Pvt. Ltd., 1988.
4. Relevant BIS Standards

MA2002D MATHEMATICS IV

Pre-requisites: MA1001D Mathematics I & MA1002D Mathematics II

Total hours: 39

L	T	P	C
3	1	0	3

Course Outcomes:

Students will be able to:

CO1: Find solutions of linear differential equations using power series method and Frobenius series method.

CO2: Formulate various engineering problems as partial differential equations and hence solve them.

CO3: Identify analytic functions and find harmonic conjugates.

CO4: Find images of regions under complex transformations.

CO5: Evaluate line integrals in the complex plane

CO6: Use techniques of complex analysis to evaluate integrals of real valued functions.

Module 1: (11 Hours)

Series Solutions and Special Functions

Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Bessel functions of the second kind, Sturm- Liouville's Problems, Orthogonal eigenfunction expansions.

Module 2: (10 Hours)

Partial differential Equations

Basic Concepts, Cauchy's problem for first order equations, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Charpit's Method, Special Types of first order equations, Classification of second order partial differential equations, Modeling: Vibrating String, Wave equation, Separation of variables, Use of Fourier Series, D'Alembert's Solution of the wave equation, Heat equation: Solution by Fourier series, Heat equation: solution by Fourier Integrals and transforms, Laplace equation, Solution of a Partial Differential Equations by Laplace transforms.

Module 3: (9 Hours)

Complex Numbers and Functions

Complex functions, Derivative , Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions.

Module 4: (9 Hours)

Complex Integration

Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions.Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

References:

1. Kreyszig E, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, New York, 1999
2. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
3. Wylie C. R. & Barret L. C., Advanced Engineering Mathematics, 6th Edition, Mc Graw Hill, NewYork,1995.
4. Donald W. Trim, Applied Partial Differential Equations, PWS – KENT publishing company, 1994.

CE2006D OPEN CHANNEL HYDRAULICS AND HYDROLOGY

Prerequisite: CE2002D Mechanics of Fluids

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Develop the open channel flow equations from the basic conservation equations.
CO2: Solve open channel flow problems through the selection and use of appropriate equations.
CO3: Explain the physical mechanisms of hydraulic jumps, surges, and critical, uniform, and gradually varied flows.
CO4: Estimate streamflow by applying energy and mass balance equations.
CO5: Determine the rate of flow for confined and unconfined aquifer and the specific capacity of well.

Module 1: (15 hours)

Uniform Open Channel Flow: Free surface flows. Comparison with pipe flow. Classification of flow in open channels. Uniform flow Equations for uniformflow Chezy‘s and Manning‘s equations. Most efficient channel sections of different geometry. Velocity distribution in open channels.Conveyance, Normal depth and Hydraulic exponent for uniform flow, Determination of normal depth and velocity. Energy concepts in free surface flows. Specific energy and Specific force diagrams, Critical flow. Hydraulic exponent for critical flow.

Nonuniform Open Channel Flow: Gradually Varied Flow Occurrence and importance. Basic assumptions. Dynamic equation for gradually varied flow. Different forms of the dynamic equation. Flow profiles in prismatic channels. Computation of the length of the backwater curve Graphical Integration and Direct Step Methods. Rapidly Varied Flow. Hydraulic Jump. Equation for a classic hydraulic jump. Practical applications. Energy loss and efficiency of a jump. tilling Basins. Selection of Stilling Basins. Standard stilling basins. Rapidly varied unsteady flow. Surges.

Module 2: (12 hours)

Surface Water Hydrology: Hydrologic cycle. Precipitation. Rainfall variations, measurement, presentation of rainfall data. Mean precipitation. Depth-Area-Duration relationships. Intensity-Duration-Frequency relationship. Abstractions from precipitation: Evaporation. Evapotranspiration. Initial loss. Infiltration. Stream flow measurement: Area-velocity method. Stage discharge relationship. Runoff. Long term runoff, Empirical formulae. Short term runoff hydrograph analysis.

Module 3: (12 hours)

Groundwater Hydrology: Soil water zones. Soil moisture relations. Specific retention. Specific yield. Occurrence of ground water. Types of aquifers: Unconfined aquifer. Confined aquifer. Perched water table. Leaky aquifer. Storage coefficients. Governing differential equation for confined groundwater flow. Darcy’s law. Transmissivity. Flow between two water bodies through a confined aquifer. One-dimensional confined aquifer. Dupuit’s assumptions. Hydraulics of wells: Steady confined and unconfined flows into a well. Well losses, Evaluation of well losses, Specific capacity. Ground water quality criteria, pollution of groundwater: causes and monitoring. Distribution of pollution underground. Saline water intrusion in aquifers and control.

References:

1. VenTe Chow, Open Channel Hydraulics, McGraw Hill, Inc.., New York, 1951.
2. VenTe Chow et al.,Applied Hydrology, McGrawHill Book Company, NY, 1988.
3. French, R. H., OpenChannel Hydraulics, McGrawHill, New York, 1985

4. Subramanya K.,Flow in Open Channels, Tata McGraw Hill, 1990.
5. HanifChaudhry M., Open Channel Flow, Prentice Hall of India. 1994.
6. Rangaraju K. G., Flow through Open Channels, Tata McGrawHill, 1984.
7. Rajesh Srivastava., Flow Through Open Channels, Oxford University Press, 2008.
8. Subramanya K., Engineering Hydrology, Tata McGraw-Hill Publishers, 2008.
9. Linsley W., Water Resources Handbook, McGraw–Hill International Edition, 1996.
10. Mays L. W., Water Resources Engineering, John Wiley and Sons, New York, 2001.
11. Todd D. K., Groundwater Hydrology, John Wiley and Sons, New York, 1958.
12. Raghunath, Ground Water, New Age International (P) Ltd. Publishers, 1987.
13. Kashef A. I. Groundwater Engineering. McGraw-Hill Book Company, 1987.

CE2007D FUNCTIONAL DESIGN OF BUILDINGS

Prerequisite: CE2003D Building Technology

L	T	P	C
3	1	0	3

Total hours: 39

Course outcomes:

Students will be able to:

CO1: Gain knowledge about the details of anthropometrics and ergonomics.

CO2: Understand the essentials of the National Building Code, Development Rules and Green Building concepts.

CO3: Calculate the heat flow in buildings.

CO4: To design various building services.

CO5: Assess acoustics and lighting in rooms.

Module 1: (14 hours)

Functional planning : Introduction to anthropometrics and ergonomics ;Occupancy classification of Buildings ; Essentials of National Building Code ; Essentials of Building and development rules ; Introduction to green building ; Introduction to human comfort- factors involved, comfort indices;

Vertical transportation: Stairs - types and design considerations; Elevators - types and design considerations; Escalators - features, operation & arrangement; Ramps.

Plumbing services: Typical details of water supply and sewage disposal arrangements for buildings, standard requirements.

Module 2: (15 hours)
Building Physics

Thermo-physical properties of building materials: Thermal quantities and their units; Periodic heat flow and its characteristics; Heat flow calculations; Thermal gradient.

Sun's movement and building: Sun control devices; External shading devices; Internal blinds and curtains and Special glasses.

Thermal insulation – Materials and properties; Thermal insulation of roofs, exposed walls and openings.

Ventilation and air conditioning: Ventilation requirements; Natural and mechanical ventilation ; Air conditioning ; Heat exchange of building ; Calculation of air conditioning load ; Summer and winter air conditioning ; Parts and operation of a/c plant - Systems of air conditioning.

Module 3: (10 hours)

Lighting : Photometric quantities , Day lighting ,Day light factor and components ; Artificial lighting , Lamps and luminaries ; Polar distribution curves , Design of artificial lighting - Lumen method , Point by point method ; Glare , Measurement of illumination.

Acoustics : Room acoustics , Reverberation ,Sabine's formula , Acoustical defects ; Sound absorbing materials and constructions; General principles of acoustic design ; Sound insulation – materials and construction, Transmission loss.

References:

1. SP 7:2005, National Building Code of India
2. Koenigsberger, O.H, Manual of Tropical Housing and Building – Climatic Design, Universities Press (India), 2014.
3. Punmia, B. C., Building Construction, Laxmi Publications, New Delhi, 1999.
4. Rangwala, S. C., Building Construction, Charotar Publishing House, 1992.
5. Callender, John Hancock, Time Saver Standards for Architectural Design Data, McGraw Hill, 2000.
6. IS 5533 : 1969, Recommendation for Dimensions of Spaces for Human Activities, B.I.S
7. IS 4963 : 1987, Recommendation for Buildings and facilities for the Physically Handicapped, B.I.S

CE2008D STRUCTURAL ANALYSIS I

Pre-requisites: CE2001D Mechanics of Solids

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Provide basic energy based analysis techniques for analysing structures

CO2: Acquire the knowledge regarding the behaviour of the column under axial and eccentric loading.

CO3: Use different analytical tools for understanding the behaviour of statically determinate and indeterminate structures using force method

CO4: Equip with the comprehensive methods of structural analysis with emphasis on analysis of elementary structures and to attain ability to pursue higher studies in Civil Engineering.

Module 1: (14 hours)

Elastic theorems and energy principles: Strain energy and complementary energy - review of strain energy due to axial load - bending, shear and torsion - principle of superposition - principle of virtual work - Castigliano's theorem for deflection - theorem of complementary energy -Betti's theorem - Maxwell's law of reciprocal deflections - application of method of virtual work (unit load method) and strain energy method for determination of deflections of statically determinate beams - pin-joined trusses and rigid frames - temperature effects.

Module 2: (14 hours)

Theory of columns: Axial loading of short strut - long columns - differential equation of elastic curve – Euler's formula - eccentric loading - direct and bending stresses – buckling load as an eigenvalue problem.

Force method of analysis of indeterminate structures: Indeterminate structures - degree of static and kinematic indeterminacies - introduction to force and displacement methods

Fixed and continuous beams: Fixed and continuous beams - force method - analysis by consistent deformation method - shear force and bending moment diagrams - deflection and support settlement

Module 3: (11 hours)

Indeterminate Frames and Trusses: Deflection of rigid frames of different geometry by consistent deformation method - settlement effects - analysis of trusses by consistent deformation method - externally and internally redundant trusses - effects of support settlement and pre-strains.

References:

1. Wilbur, J.B., Norris, C.H., and Utku, S., Elementary Structural Analysis, McGraw Hill, New York, 2006.
2. Wang, C.K., Intermediate Structural Analysis, McGraw Hill, New York,1989.
3. Timoshenko, S.P., and Young, D.H., Theory of Structures, McGraw Hill, New York, 1988.
4. Reddy, C.S., Basic Structural Analysis, Tata McGraw Hill, New Delhi, 2007.
5. Negi, L.S., and Jangid, R.S, Structural Analysis, Tata McGraw Hill, New Delhi, 2006.
6. Menon, D., Structural Analysis, Narosa publishers, New Delhi, 2008.
7. Hibbler, R.C., Structural Analysis, Pearson Education, India, 2006.

CE2009D GEOTECHNICAL ENGINEERING I

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39
Course Outcomes:

Students will be able to:

CO1: Understand the soil formation, soil mass structure and soil classification systems

CO2: Familiarize with engineering properties of soils like compressibility and compaction, shear strength, permeability and their determination

CO3: Analyze the stress distribution beneath the footing for any loaded structure

CO4: Familiarize with different types of slopes and analyze the stability of landslides

Module 1: (14 hours)

Nature of soil and functional relationships: Soil type -Concepts of single grained, honeycombed and flocculent structure and their effects on the basic soil properties - 3 phase system -void ratio - specific gravity - dry density - porosity - water content - saturated unit weight -submerged unit weight - degree of saturation; **Laboratory and field identification of soils:** Determination of water content by oven drying -Specific gravity using pycnometer and specific gravity bottle - Grain size analysis by sieveanalysis, hydrometer analysis and pipette analysis – Atterberg's limits and indices – Visualidentification by simple field tests - Field density by core cutter, sand replacement and waxcoating methods; **Classification of soils:** Necessity -Principles of classification - I.S. classification – Plasticitycharts - Group index; **Soil water:** Types - Effective stress - Total stress - Pore pressure - Pressure diagrams; **Permeability:** Definition - Darcy's law - Factors affecting permeability – Laboratorydetermination - Stratified soils: average permeability

Module 2: (13 hours)

Stress distribution: Boussinesq's equations for vertical pressure due to point loads-Assumptionsand limitations - pressure bulb – Influence diagram - Vertical pressure due to uniformlydistributed loads, line loads and strip loads - Newmark charts and their use - Westergaard's solution; **Compaction:** Definition and objectives of compaction - Proctor test and modified proctor test -Concept of OMC and maximum dry density - Zero air voids line -Factors influencing compaction-Effect of compaction on soil properties - Field compaction methods - Proctor needle for field control; **Consolidation:** Definition - Concepts of coefficient of compressibility - Coefficient of volumechange and compression index - e-log p curves - Terzaghi's theory of one dimensionalconsolidation – Determination of coefficient of consolidation- pre-consolidation pressuredifference between consolidation and compaction

Module 3: (12 hours)

Shear Strength: Definition - Mohr's strength and stress circles - origin of planes - Mohr'senvelope - Mohr-Coulomb strength theory -Direct, triaxial and UCC tests - Drainage conditions -Measurement of pore pressure - Vane shear tests -Total and effective stress -strength parameters –Stress path, Liquefaction of sand - Choice of test conditions for field problems; **Stability of slopes:** Slope failure, base failure and toe failure - Swedish circle method - φ=0analysis and c=0 analysis - Friction circle method - Taylor's stability number -Stability charts -Sliding block analysis.

References:

1. Terzaghi K. & Peck R.B., Soil Mechanics in Engineering Practice, 3rd edition, John Wiley Sons, 1996
2. Alam Singh, Soil Engineering-In Theory and Practice, 4th edition, CBS Pub, 2012
3. Punmia B.C., Soil Mechanics and Foundations, 16th edition, Laxmi Pub.,2005
4. Murthy V.N.S., Soil Mechanics and Foundation Engineering, CBS Pub., 2009
5. Khan I.H., Text Book of Geotechnical Engineering, 3rd edition, PHI Limited, 2012

CE2010D ENVIRONMENTAL STUDIES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Demonstrate a general understanding of the breadth and interdisciplinary nature of environmental issues

CO2: Discuss the different natural resources and problems associated with its consumption

CO3: Discuss the different types of ecosystems, their occurrence and characteristic features

CO4: Demonstrate knowledge in biodiversity and its conservation

CO5: Respond effectively to natural disasters

Module 1: (13 hours)

Multidisciplinary nature of environmental studies -Definition, scope and importance -Need for public awareness.

Natural Resources - Renewable and non-renewable resources: Natural resources and associated problems- Forest resources: Use and over-exploitation, deforestation, case studies,timber extraction, mining, dams and their effects on forest and tribal people- Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams, its benefits and problems- Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies- Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies- Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies- Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources -Equitable use of resources for sustainable lifestyles.

Module 2: (13 hours)

Ecosystems: Concept of an ecosystem,Structure and function of an ecosystem, Producers, consumers and decomposers- Energy flow in the ecosystem-Ecological succession- Food chains-food webs and ecological pyramids.

Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: Introduction, genetic, species and ecosystem diversity- Biogeographical classification of India -Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values -Biodiversity at global, National and local levels.

India as a mega-diversity nation: Hot-sports of biodiversity- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. -Endangered and endemic species of India- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Module 3: (13 hours)

Disaster management: floods, earthquake, cyclone and landslides.

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people, its problems and concerns, Case studies- Environmental ethics : Issues and possible solutions: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case Studies- Wasteland reclamation- Consumerism and waste products.

Field work:

- Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

References:

1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, New Delhi: University Grants Commission, 2013
2. Kevin J. Gaston, John I. Spicer, Biodiversity: An Introduction, New Jersey, USA: Wiley-Blackwell, 2004
3. N C Asthana, Priyamvada Asthana, Natural Disaster Management, New Delhi, India: Raj Publications, 2015

CE2093D BUILDING DESIGN AND DRAWING

Pre-requisites: CE2003D Building Technology

Total hours: 39

L	T	P	C
0	0	3	2

Course Outcomes:

Students will be able to:

CO1: Plan and design from given requirements of areas & specifications and preparation of sketch design and working drawings for Residential building- flat and pitched roof, economic domestic units, cottages, bungalows and building flats.

CO2: Plan and design from given requirements of Public building – small public utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.

CO3: Prepare site plans and service plans as per Building Rules.

CO4: Prepare detailed drawings of Septic tank and Soak Pit.

CO5: Prepare detailed drawings for Plumbing, water supply and drainage for buildings.

Detailed Drawings of:

1. Panelled doors, glazed windows and ventilators in wood
2. Steel and aluminium windows
3. Steel roof trusses
4. Reinforced concrete staircase

Planning, designing from given requirements of areas & specifications and preparation of sketch design and working drawings for:

1. Residential building- flat and pitched roof, economic domestic units, cottages, bungalows and building flats
2. Public building – small public utility shelters, dispensaries, banks, schools, offices, libraries, hostels, restaurants, commercial complexes, factories etc.
3. Preparation of site plans and service plans as per Building Rules
4. Septic Tank and Soak Pit – detailed drawings.
5. Plumbing, water supply and drainage for buildings.

References:

1. SP 7:2005,National Building Code of India
2. Balagopal T S Prabhu, Building Drawing and Detailing, Spades Publishers, 2007.
3. Local Building Bye-laws
4. Callender, John Hancock, Time Saver Standards for Architectural Design Data, McGraw Hill, 2000.
5. Chiara, Callender, John Hancock, Time Saver Standards for Building Type, McGraw Hill, 2001.
6. Chiara, Joseph De, Time Saver Standards for Site Planning, McGraw Hill, 1999.
7. Ching, Francis D K, Architectural Graphics. .John Wiley, 2009.
8. Ching, Frank, Architecture – Form, Space and Order.John Wiley, 2007.
9. Ramsey Sleeper, Architectural Graphic Standards, John Wiley, 2001.
10. Scott Robert Gillan, Design Fundamentals, Mc-Graw Hill, 1951.
11. Tessie Agan M.S., The House, Its Plan & Use, Oxford and IBH Publishing Co., 2000.
12. IS 5533 : 1969, Recommendation for Dimensions of Spaces for Human Activities. B.I.S
13. IS 4963 : 1987, Recommendation for Buildings and facilities for the Physically Handicapped. B.I.S
14. Shaw and Kale, Building Drawing, Tata Mc Graw Hill Publishers, 2000.

CE2094D MATERIAL TESTING LABORATORY II

Pre-requisites: CE2001D Mechanics of Solids

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Integrate the hands on experience on material testing with their theoretical understanding of mechanical behaviour of materials

CO2: Prepare reports and present the results based on the test data complying to the codes/regulations

CO3: Refer codes and other reference materials for standard property data

CO4: Interpret the results and recommend the suitability of a material for a given load case

List of Exercises:

1. Tension test on MS rod
2. Shear Test on MS rod
3. Torsion test on MS Specimen
4. Bending test on steel beams
5. Spring test – open and close coil springs
6. Workability tests – slump, compaction, V-bee, flow and preparation of cubes
7. Compression test on cubes and cylinders – determination of modulus of elasticity
8. Split test on concrete cylinders and flexure test on concrete
9. Study of extensometers and strain gauges
10. Bending test on reinforced concrete beams – under reinforced and over reinforced.
11. Demonstration of Non- Destructive Testing Equipment.

References:

1. Neville, A. M., Properties of Concrete, Pitman, 1987.
2. Shetty, M. S., Concrete Technology, S I Chand and Company, 1993.
3. Timoshenko, S.P., Strength of materials, CBS publishers Pvt. Ltd., 1988.
4. Relevant BIS Standards

CE 3001D STRUCTURAL ANALYSIS II

Pre-requisites: CE2008D Structural Analysis I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Use different analytical tools for understanding the behaviour of statically determinate and indeterminate structures using displacement method

CO2: Determine the required design forces in a structure subjected to moving loads like bridges

CO3: Analyze cables, suspension bridges with three-hinged and two-hinged stiffening girders and statically determinate and indeterminate arches

CO4: Carry out plastic analysis of beams and portal frames by equilibrium and mechanism methods

CO5: Determine bending moment, shear force and axial force in the frames subjected lateral and vertical loads using approximate methods

Module 1 (13 hours)

Displacement method of analysis of indeterminate structures: Slope deflection method - analysis of continuous beams - beams with overhang - analysis of rigid frames - frames with sloping legs - gabled frames - frames without sway and with sway -settlement effects - moment distribution method as successive approximation of slope deflection equations - analysis of beams and frames - non-sway and sway analyses-prestrain and temperature effects.

Module 2 (13 hours)

Moving loads and Influence lines: Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams - influence lines for forces in trusses – analysis for different types of moving loads - single concentrated load - several concentrated loads - uniformly distributed load shorter and longer than the span.

Cables, suspension bridges and arches: Analysis of forces in cables - suspension bridges with three-hinged and two-hinged stiffening girders - theory of arches - Eddy‘s theorem - analysis of three-hinged and two-hinged arches - settlement and temperature effects.

Module 3 (13hours)

Plastic Analysis: Plastic theory - introduction - plastic hinge concept - plastic modulus - shape factor - redistribution of moments - collapse mechanism - plastic analysis of beams and portal frames by equilibrium and mechanism methods.

Approximate methods of analysis of multi-storey frames: Analysis for vertical load - substitute frames - loading condition for maximum positive and negative bending moment in beams and maximum bending moment in columns - analysis for lateral load - portal method - cantilever method.

References:

1. Wilbur, J.B., et al, Elementary Structural Analysis, McGraw Hill, New York, 2006.
2. Wang, C.K., Intermediate Structural Analysis, McGraw Hill, New York, 1989.
3. Timoshenko, S.P., and Young, D.H., Theory of Structures, McGraw Hill, New York, 1988.
4. Reddy, C.S., Basic Structural Analysis, Tata McGraw Hill, New Delhi, 2007.
5. Negi, L.S., and Jangid, R.S, Structural Analysis, Tata McGraw Hill, New Delhi,2006.
6. Menon, D., Structural Analysis, Narosa publishers, New Delhi, 2008.
7. Hibbler, R.C., Structural Analysis, Pearson Education, India, 2006.

CE3002D STRUCTURAL DESIGN I

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Understand the basic principles of structural design

CO2: Expose the stake holders to the various concrete design codes

CO3: Acquire knowledge of limit state design with respect to limit state of collapse against flexure, shear, torsion and compression and limit states of serviceability

CO4: Familiarize the design principles of foundation and retaining wall

CO5: Familiarize the design principles of prestressed concrete and seismic detailing

Module 1 (13 hours)

Design philosophies: Introduction to different design philosophies- working stress method-ultimate load method -limit state method - characteristic strength – characteristic loads – design values – partial safety factors – limit state of collapse – limit state of serviceability.

Materials: Properties of concrete and reinforcing steel – stress strain curves.

Flexure: Types of cross sections – rectangular – singly reinforced – doubly reinforced – flanged sections – analysis at service conditions – modes of failure in flexure – under reinforced – over reinforced – balanced sections – limiting moment of resistance – strain compatibility method – IS code procedure – design for flexure.

Module 2 (13 hours)

Shear and Torsion: Modes of failure in shear – critical sections – nominal shear stress-shear strength of concrete – design for shear – modes of failure in torsion – design for torsion.

Control of deflections and cracking: IS code procedures – allowable span to depth ratios – detailing recommendations.

Beams and slabs: Design of beams– design of one way slabs and two way slabs – stair case design.

Module 3 (13 hours)

Compression members: classification – short and slender columns – types of cross sections - analysis and design of axially loaded columns -columns with uniaxial and biaxial eccentricity – interaction diagrams.

Footings and retaining walls: Types of footings– design of isolated and continuous footings –retaining wall.

Principles of prestressed concrete – Principles of earthquake resistant design and seismic detailing.

References:

1. Varghese, P. C., Limit State Design of Reinforced Concrete, Prentice Hall of India, 2003.
2. Jain, A. K., Reinforced Concrete -Limit State Design, Nem Chand and Bros., 2015.
3. Pillai, S. U., and Menon, D., Reinforced Concrete Design Tata McGraw Hill, New Delhi, 2003.
4. Sinha, S. N., Reinforced Concrete Design, Tata McGraw Hill, New Delhi, 2005.
5. Mallick, S. K., and Gupta, A. K., Reinforced Concrete, Oxford and IBH, 1982.
6. Wight and Macgregor., Reinforced concrete:Mechanics and Design, Pearson, 2011.
7. Relevant BIS Codes.(IS 456, IS: 1343, SP 16)

CE3003D NUMERICAL METHODS IN CIVIL ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Choose a suitable numerical method for an application problem in civil engineering.

CO2: Solve problems using numerical methods with a required accuracy

CO3: Explain the theoretical background of the numerical methods and optimisation techniques.

CO4: Write algorithm for the numerical methods and optimisation techniques so that computer programmes can be coded systematically

CO5: Assess the error involved in a numerical method

Module 1: (10 hours)

Introduction to Numerical Methods in Civil Engineering: importance of numerical methods in civil engineering - sources of errors in numerical methods - number representations - fixed and floating point numbers - significant digits - round off errors - development of computer algorithms - pseudo code. **Solution of Algebraic and Transcendental Equations in One Variable:** bisection method - method of false position - Newton-Raphson method - successive approximation method - development of computer algorithms for each of the above methods

System of Linear Algebraic Equations: solution of linear algebraic equations using Gauss elimination method and LU decomposition method - solution by iterative method - conditions of convergence-Ill conditioned system of equations.

Applications in Civil Engineering Problems

Module 2: (10 hours)

Eigen Value Problems: determination of eigen values and eigen vectors by Power method and Jacobi‘s method

Interpolation: Newton‘s formulae - Gauss‘ formulae - Lagrangian interpolation - Cubic spline interpolation Applications in Civil Engineering Problems

Module 3: (10 hours)

Numerical differentiation and integration: numerical differentiation using Newton‘s formula - maximum and minimum values of tabulated functions - numerical integration - trapezoidal formula - Simpson‘s formulae and Gauss quadrature - development of computer algorithms for numerical integration **Numerical solution of ordinary differential equations:** Taylor‘s series method - Euler‘s method - Runge-Kutta method - finite difference method for the solution of boundary value problems Applications in Civil Engineering Problems.

Module 4: (9 hours)

Linear programming problems: statement of an optimisation problem - linear and nonlinear programming problems - standard form of linear programming problems - applications of linear programming in civil engineering

Introduction to nonlinear programming problems: (outline only - descriptive questions only are expected) - difficulties in nonlinear programming problems - unconstrained optimization problems - unimodal function - search methods - one dimensional minimization methods - Fibonacci and golden section methods - examples of one dimensional minimization problems in civil engineering.

References:

1. Sastry, S. S., Introductory Methods of Numerical Analysis, Prentice Hall of India, 2003.
2. Scarborough, J. B., Numerical Mathematical Analysis, Oxford and IBH, 1971.
3. Chapra, S. C., and Canale, R. P., Numerical Methods for Engineers, McGraw Hill, Inc., 2007.
4. Rao S. S., Engineering Optimization - Theory and Applications, New Age International Publishers, 2007.

CE3004D GEOTECHNICAL ENGINEERING II

Pre-requisites: CE2009D Geotechnical Engineering I

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: To suggest a suitable type of Soil investigation technique for a particular site and structure

CO2: To decide up on the type of field tests required, if any.

CO3: To estimate the bearing capacity of soils

CO4: To design both shallow and deep foundations

CO5: To estimate the probable settlements of foundations

Module 1: (15 hours)

Earth pressure:Earth pressure at rest - Active and passive earth pressure for cohesionless andcohesive soils - Coulomb's and Rankine's theories - Point of application of earth pressure forcases of with and without surcharge in cohesionless and cohesive soils - Culmann's andRebhan's graphical construction for active earth pressure- Friction circle method for active earth pressure; **Site investigation and soil exploration**: Objectives - Planning -Reconnaissance – Depth ofexploration - Methods of subsurface exploration - test pits -auger borings – wash boring -rotary drilling – percussion drilling – core drilling –Sampling - Types of soil samples- Splitspoonsampler - Thin walled sampler – Piston sampler-Denison sampler - hand cut samples -Location of water table - S.P.T. - Field vane shear test - Geophysical methods (in brief) - Boring log - Soil profile; **Bearing capacity**: Ultimate and allowable bearing capacity - Terzaghi's equation for bearingcapacity for continuous circular and square footings –Types of shear failures – Bearingcapacity factors and charts - Effect of water table on bearing capacity – Meyerhoff's bearingcapacity theory - Skempton's formulae – Bearing capacity from field tests - Bearing capacityfrom building codes - Net bearing pressure - Methods of improvement of soil bearingcapacity: vibro flotation and sand drains

Module 2: (12 hours)

Settlement analysis: Distribution of contact pressure - Immediate and consolidationsettlement - Estimation of initial and final settlement under building loads - Limitations insettlement computation - Causes of settlement - Permissible, total and differential settlements- Cracks and effects of settlement; **Foundation - general consideration**: Functions of foundations - Requisites of satisfactoryfoundations - Different types of foundations - Definition of shallow and deep foundation - Selection of type of foundation - Advantages and limitations of various types of foundations -Design considerations - Footings subjected to eccentric loading - conventional procedure forproportioning footings for equal settlements; **Open excavation:** Open foundation excavations with unsupported slopes - Supports forshallow and deep excavations - Stress distribution in sheeting and bracing of shallow anddeep excavations - Stability of bottom of excavations; **Raft foundations**: Bearing capacity equations - Design considerations – Conventional design procedure for rigid mat - Uplift pressures - Methods of resisting uplift -Floating foundations

Module 3: (12 hours)

Pile foundations: Uses of piles - Classification of piles based on purpose and material - Determination of type and length of piles -Determination of bearing capacity of axially loadedsingle vertical pile - (static and dynamic formulae) - Determination of bearing capacity bypenetration tests and pile load tests (IS methods) - Negative skin friction - Group action andpile spacing - Analysis of pile groups - Load distribution by Culmann's method; **Caissons and piers:** Open (well) caissons -Box (floating) caissons - Pneumatic caissons -Construction details and design considerations of well foundations Drilled piers and theirconstruction details.

Note: Structural designs of foundations are not contemplated in this course

References:

1. Joseph E. & Bowles, *Foundation Analysis & Design*,5th edition, McGraw Hill Pub., 2001
2. Leonards G.A., *Foundation Engineering*, McGraw Hill Pub., 1962
3. Teng W.C., Foundation Design, PHI Pub., 1962
4. Tomlinson M.J., Foundation Design & Construction, 7th edition, PHI Pub., 2001
5. Terzaghi & Peck, Soil Mechanics in Engineering Practice, 3rd edition, John Wiley Sons, 1996
6. Arora K.R., *Soil Mechanics & Foundation Engg.,* Standard Pub., 2009
7. Murthy V.N.S., Soil Mechanics & Foundations, CBS Pub., 2009
8. Iqubal H. Khan, Geo-technical Engineering, 3rd edition, PHI Limited, 2012
9. Punmia B.C., Soil Mechanics & Foundations, 16th edition, Laxmi Pub.,2005

CE3005D TRANSPORTATION ENGINEERING I

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Fix the horizontal and vertical alignments of roads and design the elements.
CO2: Suggest and design circulation improvement measures.
CO3: Identify and test the properties of pavement materials.
CO4: Design flexible and rigid pavements.
CO5: Identify probable causes of distress of pavements and suggest remedial measures.

Module 1: (10 hours)

Highway Classification, Alignment and Geometrical Design: Introduction - Highway development in India - Classification of roads - Typical cross sections of roads in urban and rural area - Requirements and factors controlling alignment of roads -Engineering surveys for highway location - Pavement surface characteristics - Camber and width requirements - Sight distances - stopping and overtaking sight distances, overtaking zone requirements - Design of horizontal alignment -speed, radius, super elevation, methods of providing superelevation, extra widening at curves, transition curves - Design of vertical alignment - gradient, grade compensation, summit curves and valley curves - worked out problems on all the above topics.

Module 2: (10 hours)

Traffic engineering: Introduction - Road user, vehicle and traffic characteristics - Speed, volume, delay, O-D, parking studies - Simple worked out problems - Principles of design of at-grade intersections - Simple layouts - Objectives, classification and uses of traffic signs and markings - Design of isolated signals.

Module 3: (10 hours)

Pavement Materials and Design: Desirable properties and testing of highway materials: road aggregates, bituminous materials and subgrade soil – Superpave - Factors influencing the design of pavements - Design of flexible and rigid pavements- IRC guidelines – BBD method of flexible overlay design - worked out problems– Introduction to Mechanistic Empirical Pavement Design.

Module 4: (09 hours)

Pavement Construction and Maintenance: Historical development of road construction - Construction of earth roads, WBM roads, stabilized roads, bituminous pavements, cement concrete roads and joints in cement concrete roads - Types and causes of distresses in flexible & rigid pavements – Remedial measures – Recycling of pavements.

References:

1. Khanna, S.K.,and Justo, C.E.G., Highway Engineering, Nemchandand Bros, 2015, Roorkee.
2. Kadiyali, L.R.,andLal, N.B., Principles and Practices of Highway Engineering, Khanna Publishers, 2013.
3. O' Flaherty, C.A., Highway-Traffic Planning and Engineering, Edward Arnold., 1986
4. Yoder and Witczak, Principles of Pavement Design, John Wiley and Sons, 1975
5. IRC: 37, Guidelines for the Design of Flexible Pavements.
6. IRC: 58, Guidelines for the Design of Rigid Pavements.
7. IRC:15, Standard Specifications and Code of Practice for Construction of Concrete Roads
8. Ministry of Road Transport and Highways Specifications for Roads and Bridges.
9. David Croney, The Design and Performance of Road Pavements, McGraw Hill, 1997
10. Paul H. Wright and Karen Dixon, Highway Engineering, Wiley, 2003

CE3091D TRANSPORTATION ENGINEERING LABORATORY

Pre-requisite: CE3005D Transportation Engineering I or its Concurrent Registration

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Integrate the hands on experience on material testing with their theoretical understanding of highway materials
CO2: Prepare reports and present the results based on the test data complying to the codes/regulations
CO3: Refer codes and other reference materials for standard property data.
CO4: Interpret the results and recommend the suitability of a material for a given Highway use.

Laboratory Exercises:

Highway Materials Testing:
- Tests on Aggregate for Highway
- Tests on Bitumen
- Tests on Emulsion

Design of Asphalt Concrete Mixes:
- Marshall Stability Test

Pavement Evaluation Tests:
- Benkleman Beam test
- Roughness Test

References:

1. Khanna, S.K.,Justo, C.E.G., Veeraragavan. A. Highway Engineering, Nemchandand Bros, 2015, Roorkee.
2. Khanna, S.K.,Justo, C.E.G; Veeraragavan. A. Highway Materials and Pavement Testing.Nemchandand Bros, 2015, Roorkee
3. Relevant BIS Standards

CE3092D GEOTECHNICAL ENGINEERING LABORATORY

Pre-requisites: CE2009D Geotechnical Engineering I

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

The student will be able to

CO1: Identify different types of soils both in the laboratory and field

CO2: Determine their physical and engineering properties

CO3: Operate the different Soil testing equipment and conduct field density / field CBR tests

List of experiments:

1. Specific gravity of coarse and fine grained soils
2. Grain size analysis (a) Sieve analysis (b) Pipette analysis
3. Atterberg's limits and indices
4. Determination of field density (a) sand replacement method, (b) Core cutter method
5. Determination of coefficient of permeability by (a) Constant head method, (b) Variable head method
6. Consolidation test
7. Compaction test (a) IS light compaction test, (b) IS heavy compaction test
8. California Bearing Ratio test
9. Direct shear test
10. Triaxial shear test
11. Unconfined compressive strength test
12. Laboratory vane shear test

References:

1. Relevant Indian standard codes
2. Geotechnical Laboratory Record, NITC
3. K.H. Head, Manual of Soil Laboratory Testing, Whittles Publishing, 3rd edition, 2006

CE3006D WATER RESOURCES ENGINEERING I

Pre-requisites: CE2006D Open Channel Hydraulics and Hydrology

Total hours: 39

L	T	P	C
3	0	0	3

Course Outcomes:

The students will be able to
CO1: Design rigid boundary channels and regime channels in erodible medium.
CO2: Compute crop water and irrigation water requirements.
CO3: Plan and execute a canal network in the field.
CO4: Plan and design diversion headworks.
CO5: Plan and design canal regulators, canal drops, canal escapes, cross drainage works.

Module 1: (6 hours) Water resources projects

Range of water resources projects - General planning philosophy- Water allocation priorities. Data requirement and data collection for different projects. Environmental checklist for Water Resources projects. Irrigation - Development of Irrigation in India- Major-Medium and minor irrigation schemes– Command area development and participatory irrigation management. Planning of Irrigation projects.

Module 2: (10 hours) Irrigation Engineering

Soil water system – Soil classification - Soil water constants - Consumptive use - Crops- crop seasons, cropping patterns and crop water requirements. Irrigation water requirement. Methods of irrigation and Irrigation efficiency. Classification of irrigation projects -Direct and storage irrigation - Irrigation project components. Diversion structures for direct irrigation - Weirs and Barrages – Site selection -Components of diversion head work. Design of weirs / barrages – Hydraulic design for water way and sub surface flow - Bligh‘s and Khosla‘s theories. Structural design of different elements. Training and protection works.

Module 3: (10 hours) Distribution system

Distribution canals - classification, alignment and components of canals. Canal regulation. Transport of sediment in canals. Design of rigid boundary canals. Design of alluvial channels. Regime channels-Kennedy‘s and Lacey‘s methods. Water logging and drainage of irrigated lands.

Module 4: (13 hours) Canal structures

Canal regulation structures- canal falls-different types of canal falls and selection of type-Structural elements of a fall - Design of vertical, notch type and siphon drops. Canal headwork Head and cross regulators- Design criteria – sediment control at head regulator- Design of a regulator. Canal escapes-Weir and sluice escapes. Outlets- modular and non-modular outlets. Cross Drainage structures-Need - Types- Design considerations – design of a type III aqueduct.

References:

1. R. S. Varshney, S. C. Gupta, and R. L. Gupta, Theory and Design of Irrigation Structures, Vol. II, Nem Chand Publication, 2007.
2. S. K. Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2017.
3. P. N. Modi, Irrigation Water resources and Water power engineering, Standard book house, 2008.
4. G. L. Asawa, Irrigation and water resources Engineering, New Age Publications, 2005.
5. FAO Irrigation, Water resources and Drainage Papers, 26/1,26/2 Small Hydraulic Structures, Vol 1 and 2, 1982.
6. FAO Irrigation water management Training Manuals 1(1985), 3(1986), 4(1988), and 5(1989)
7. All relevant BIS codes.

CE3007D STRUCTURAL DESIGN II

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:
CO1: Design timber structures
CO2: Decide upon the type of structural steel connections and its design
CO3: Design members subjected to tension
CO4: Design steel girders - simple and compound beams, open web girders and castellated beams
CO5: Design both axially and eccentrically loaded columns and column bases
CO6: Carryout analysis and design of structural steel roof trusses, purlins bracings etc.

Module 1 (13 hours)

Timber structures: Classification - allowable stresses - design of beams for flexure, shear and bearing - deflection criteria - design of solid and built-up columns-flitched beams – formwork design.

Steel Structures: Introduction to connections - analysis and design of riveted, bolted and welded joints for direct force and moment –design of tension members.

Module 2 (12 hours)

Design of steel flexural members: Analysis and design of laterally restrained – unrestrained – simple and compound beams –deflection criteria - check for shear - open web girders – castellated beams

Module 3 (14 hours)

Design of steel compression members: Axially and eccentrically loaded compression members - built up columns - lacings and battens - design of column bases.

Introduction to steel roof systems: wind load on truss – load combinations -design of roof trusses – design of roofing elements and purlin – wind bracings.

References:

1. Subramanian, N., Design of Steel Structures, Oxford University Press, 2008.
2. Sairam, K.S., Design of steel structures, Pearson, 2013.
3. Bhavikatti, S. S., Design of Steel Structures, I K International Publishing House (P) Ltd., New Delhi, 2009.
4. Duggal, S. K., Limit State of Design of Steel Structures, Tata McGraw Hill, New Delhi, 2010.
5. Relevant BIS codes(IS 883 , IS 800, SP 6, IS 875)
6. Arya, A. S., and Ajmani, J. L.,Design of Steel Structures, Nem Chand, 2011.

CE3008D TRANSPORTATION ENGINEERING II

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

The students will be able to:
CO1: Design a railway track and various components such as points & crossings, for the given conditions.
CO2: Identify signaling and interlocking systems required for train movement control.
CO3: Draw the track maintenance schedule.
CO4: Select the appropriate tunneling method and tunnel lining.
CO5: Identify requirements, sizing and sitting of airport and airside facilities.
CO6: Design runway, taxiway, apron, parking facilities and airport drainage systems.

Module 1: (10 hours)

Components & Geometric Design of Railways: Introduction - Typical cross-sections -Gauges - Coning of wheels and tilting of rails - Functions and requirements of component parts of a railway track -Creep of rails - Geometrical design of railway track –Horizontal curves, radius, superelevation, cant deficiency, transition curves, safe speed on curves, different types of gradients, grade compensation - worked out problems - Modern Track based Systems

Module 2: (10 hours)

Railway Operation and Control: Points and crossings and their design -Track junctions and simple track layouts - Details of different types of stations and yards - Signaling and interlocking –Train movement control systems.

Railway Construction and Maintenance: Construction of railway track: earthwork, plate laying and packing - Maintenance of track-alignment - gauge, renewal of component parts and drainage, modern methods of track maintenance

Module 3: (09 hours)

Tunneling: Tunnel alignment and grade - Size and shape of a tunnel - Methods of tunneling in hard rocks - full face method, heading and bench method, drift method -Methods of tunneling in soft soils - compressed air and shield tunneling - Shafts in tunnels - Ventilation of tunnel and various methods - Lining of tunnels - Drainage and lighting of tunnels – Micro Tunneling – Trenchless technology

Module 4: (10 hours)

Airport planning and Design: Introduction - Aircraft characteristics and their influence on planning of airports -Airport obstructions and zoning - Component parts of airport and site selection - Runway design - Orientation, basic runway length, corrections and geometric design - Design of taxiways and aprons - Terminal area planning - Facilities in terminal area and their planning concepts, aircraft parking configurations -Airport drainage system - surface and subsurface drainage systems and their design

References:

1. Agarwal, M.M.,and Sathish Chandra, Railway Engineering, Oxford University, 2nd Edition, 2013
2. Khanna, S.K.,and Arora, M.G., Airport Planning and Design, Nemchand and Bros, 2005.
3. Antia, K.F., Railway Track, New Book Company Pvt. Ltd, 1960.
4. Horonjeff, R., Planning and Design of Airports, McGraw-Hill Professional, 2010
5. Mundrey, J.S., Railway Track Engineering, TMGS, 2009.
6. Richard de Neufville, Airport Systems: Planning, Design, and Management, McGraw-Hill Professional; 2013
7. Alexander, T. Wells, Airport Planning and Management, McGraw-Hill Professional; 2011

CE3009D ENVIRONMENTAL ENGINEERING I

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Identify the underlying principle and mechanism in an environmental process
CO2: Formulate an environmental risk assessment problem and quantify the risk, given the field measurements
CO3: Formulate and solve air pollution dispersion problems
CO4: Demonstrate knowledge in global atmospheric changes
CO5: Advice on the management options for solid waste and design landfills for solid waste disposal

Module 1: (13 hours)

Mass and Energy Transfer: Units of measurement- Material balance- Energy Fundamentals: Laws of thermodynamics, Heat transfer
Environmental Chemistry: Stoichiometry- Enthalpy in chemical systems- Chemical equilibrium- acid base reactions- solubility product- solubility of gases in water- Carbonate system- organic chemistry- Nuclear Chemistry
Environmental Microbiology: Types of microorganisms, Microbial metabolism-aerobic, anaerobic, microbial growth kinetics- Monod equation.

Module 2: (13 hours)

Mathematics of growth and decay: exponential growth, doubling time, half-life- Resource consumption- Human population growth- human population projections: methods of projection
Risk Assessment: Hazard identification, Dose response assessment, Exposure assessment, Risk characterization- Carcinogenic and non-carcinogenic risks- introduction to microbial risk assessment
Water Pollution: water pollutants- Biochemical Oxygen Demand- stream sanitation: Oxygen sag curve, Streeter- Phelps equation

Module 3: (13 hours)

Water quality control: Water quality standards, effluent standards- overview of water and wastewater treatment methods
Air Pollution: sources, types and effects of air pollutants, Air pollution and meteorology, Point source Gaussian plume model, indoor air quality
Global atmospheric change: The atmosphere of earth- global temperature- global energy balance- Green house effect- climate change- ozone depletion
Solid waste management: Categories of waste- Municipal solid waste- composition- characteristics- waste management strategies: source reduction, life cycle assessment, material recovery, recycling, composting of biodegradable waste, waste to energy combustion, landfills

References:

1. Gilbert M. Masters, Wendell P. Ela, Introduction to Environmental Engineering and Science, Noida, India: Pearson India Education Services Pvt. Ltd., 2015
2. Howard Peavy, Donald Rowe, George Tchobanoglous, Environmental Engineering (I Edition), New York, USA: McGraw Hill Education, 2017
3. Mackenzie L. Davis and David A. Cornwell, Introduction to Environmental Engineering (V Edition), New York, USA: McGraw Hill Education, 2017
4. Clair Sawyer, Perry McCarty and Gene Parkin, Chemistry for Environmental Engineering and Science, New York, USA: McGraw-Hill Education, 2003
5. George Tchobanoglous and Frank Kreith, Handbook of Solid Waste Management, New York, USA: McGraw-Hill Education, 2002
6. Metcalf & Eddy Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, Franklin L. Burton , Wastewater Engineering: Treatment and Resource Recovery, New York, USA: McGraw-Hill Education, 2014.

MS3003D ECONOMICS AND MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total Hours: 39

Course Outcomes:

The students will be able to:

CO1: Evaluate the economics of the management, operation, and growth and profitability of engineering firms and analyze operations of markets under varying competitive conditions

CO2: Analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis.

CO3: Produce a constructive assessment of a social problem by drawing the importance of environmental responsibility and demonstrate knowledge of global factors influencing business and ethical issues.

CO4: Use models to describe economic phenomena; analyze and make predictions about the impact of government intervention and changing market conditions on consumer and producer behavior and well-being.

CO5: Understand the key functions in management as applied in practice and to create process to solve the managerial problems.

Module 1: (9 hours)

General Foundations of Economics: Forms of organizations-Objectives of firms-Opportunity principle-Discounting, Production Possibility frontier-Central problems of an economy- Two sector, Three sector and Four sector circular flow of income. Demand analysis-Individual, Market and Firm demand, Determinants of demand and supply, Shifts and changes in demand and supply, Market equilibrium, Shortages versus surpluses, Elasticity of demand and business decision making.

Module 2: (15 hours)

Production functions in the short and long run-Cost concepts- Short run and long run costs-economies and diseconomies of scale--Product markets- Market structure-Competitive market-Imperfect competition (Monopoly, Monopolistic competition and Oligopoly) Price discrimination ; Game Theory-Prisoner's Dilemma-Maximin, Minimax, Saddle point, Nash Equilibrium,Monetary system; Indian stock market; Development Banks; NBFIs, role of Reserve Bank of India, Money Market, Capital market; NIFTY,SENSEX

Module 3: (15 hours)

Introduction to Management Theory and functional areas -Marketing, HR and Finance-Financial Management – Financial statements, Profit and Loss Statement, Fund Flow Statement, Balance Sheets, Ratio Analysis, Investment and Financial decision, Inventory Management-Functions and objectives of Inventory management – Decision models –Break even Analysis- Economic Order Quantity (EOQ) model – sensitivity analysis of EOQ model

References:

1. R.S. Pindyck, D.L. Rubinfield and P.L. Mehta,Microeconomics,Pearson Education, 9th Edition, 2018.
2. P. A. Samuelson and W.D. Nordhaus,Economics, Tata mcgraw Hill,19thed., 2015.
3. N. G. Mankiw,Principles of Microeconomics, Cengage Publications,7th ed.,2014.
4. S. B. Gupta, Monetary Economics: Institutions, Theory & Policy,New Delhi: S. Chand & Company Ltd., 2013.
5. K. E. Case, R. C. Fair and S. Oster, Principles of Economics, Prentice Hall, 10th ed., 2011.
6. R.W.Griffin, Management,Principles and Practices, Cengage India,11th ed.,2017.

Note: Supplementary materials would be suggested / supplied for select topics on financial markets and Indian economy.

ME3095D FLUID MECHANICS AND FLUID MACHINERY LABORATORY

Pre-requisites: CE2002D Mechanics of Fluids

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

The students will be able to:
CO1: Calibrate various flow measuring devices.
CO2: Evaluate various losses in flow through a piping system.
CO3: Evaluate the performance of fluid machines.

List of Exercises:

Measurement of metacentric height and radius of gyration of a floating body; calibration of flow measuring devices: venturimeter, orifice meter, notches and weirs, nozzle meters; determination of major and minor losses in piping system; verification of Bernoulli's theorem; determination of lift and drag coefficients of cylinder and airfoil; demonstration of laminar and turbulent flow in pipes; Osborne Reynolds experiment; study of jet forces; experiments on turbines: performance and operating characteristics; experiments on pumps: centrifugal pumps, reciprocating pumps, gear pumps; experiment on torque converter; flow visualization techniques; study and visualization of vortices.

References:

1. F. M. White, Fluid Mechanics, 7th ed. McGraw Hill, 2011.
2. Y. A. Cengel and J. M. Cimbala, Fluid Mechanics: Fundamentals and Applications, 3rd ed. McGraw Hill, 2014.
3. J. Lal, Hydraulic Machines, 6th ed., Metropolitan book Co., 1975.
4. J. Lal, Fluid Mechanics and Hydraulics, Metropolitan, 1975.

CE3093D COMPUTER APPLICATIONS LABORATORY

Pre-requisite: All courses up to and including 4th semester

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Carry out various civil engineering related works related to surveying, structural analysis and design, water resources, geotechnical engineering, road/railway using popular softwares for these applications.

CO2: Carry out typical drafting and documentation works.

Objective: To familiarize and give hands on training to students in the following areas of Civil Engineering Application software

List of Exercises:

1. Drafting and documentation
2. Surveying – terrain mapping, computation of areas and volumes
3. Structural Analysis and Design
4. Water resources
5. Geotechnical Engineering
6. Road/Railway system
7. Environmental Engineering
8. Estimation and Costing
9. Project Management

Recommended Packages and Softwares:

1. Auto CAD, MS Office, Matlab
2. SAP, ETABS, Staad Pro. V8i
3. Water CAD, Flow master
4. MXROAD, PTV Vissim 8
5. MS Project
6. C,C++

References:

Working manuals of all softwares and packages

CE4001D ENVIRONMENTAL ENGINEERING-II

Pre-requisites:CE3009D Environmental Engineering - I

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Prepare the design of the various units in a community water supply system with all the details

CO2: Design the various units for sewage treatment

CO3: Design anaerobic sludge treatment system with all the details

CO4: Design onsite sewage treatment systems like septic tank, soak pit and dispersion trench

Module 1: (13 hours)

Water supply engineering: Water demands- estimation of demands- surface water intakes: types and working- aeration: types, design sedimentation: plain, coagulation, designs- filtration: slow sand, rapid sand, designs- disinfection- miscellaneous treatments: removal of colour, taste, hardness, fluoride

Distribution of water: pipe lay-outs, pipe-network analysis, pumps, storage and balancing reservoirs, water loss in distribution system, house connection, valves, plumbing fixtures

Module 2: (13 hours)

Waste water engineering: Sanitary plumbing- sanitary fixtures- house drainage- storm sewage- sanitary sewage- sewers and sewer appurtenances – sewage pumping – maintenance of sewers.

Sewage treatment- design of treatment units- screening, grit removal, oil and grease trap, primary sedimentation- suspended growth treatment: Activated sludge- modifications- membrane bioreactors- Aerated lagoons- oxidation ponds, Attached growth treatment- trickling filters- rotating biological contactors

Module 3: (13 hours)

Advanced oxidation process- Electro-coagulation- Adsorption: process details, isotherms, regeneration

Sludge treatment: sludge processing- anaerobic digesters: process details, reactor design- sludge disposal. Onsite waste treatment systems- septic tank- leach pit- dispersion trenches- design of the units

Hazardous waste management: treatment, disposal

References:

1. Mackenzie Davis, Water and Wastewater Engineering, New York, USA: McGraw-Hill Education, 2010
2. Metcalf & Eddy Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, Franklin L. Burton , Wastewater Engineering: Treatment and Resource Recovery, New York, USA: McGraw-Hill Education, 2014
3. The Central Public Health and Environmental Engineering Organisation(CPHEEO), Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, Government of India
4. The Central Public Health and Environmental Engineering Organisation(CPHEEO), Manual on Water Supply and Treatment, Ministry of Urban Development, Government of India
5. Howard Peavy, Donald Rowe, George Tchobanoglous, Environmental Engineering (I Edition),New York, USA: McGraw Hill Education, 2017
6. Mackenzie L. Davis and David A. Cornwell, Introduction to Environmental Engineering (V Edition), New York, USA: McGraw Hill Education, 2017

CE4002D STRUCTURAL ANALYSIS III

Pre-requisites: CE3001D Structural Analysis II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Analyse trusses, beams and frames using matrix flexibility method and matrix stiffness method

CO2: Carry out a dynamic analysis of structural systems

CO3: Equip the students with the comprehensive methods of structural analysis and to attain ability to pursue higher studies in Civil Engineering

Module 1 (12 hours)

Flexibility method: Definition of flexibility influence coefficients - development of flexibility matrices by physical approach- flexibility matrices for truss, beam and frame elements - load transformation matrix - development of total flexibility matrix of the structure - analysis of simple structures - plane truss, beams and plane frame - nodal loads and element loads - lack of fit and temperature effects

Module 2 (12 hours)

Stiffness method: Definition of stiffness influence coefficients -development of stiffness matrices by physical approach - stiffness matrices for truss, beams and frame elements - displacement transformation matrix - development of total stiffness matrix - analysis of simple structures - plane truss, beams and plane frame - lack of fit and temperature effects

Module 3 (15 hours)

Direct stiffness method:Introduction-elementstiffness matrix - rotation transformation matrix - transformation of displacement and load vectors and stiffness matrix - assembly of stiffness matrix and load vector -determination of nodal displacements and element forces -analysis of plane truss -plane frame (with numerical examples) -analysis of grid –spacetruss and spaceframe (without numerical examples)

Introduction to structural dynamics: Single degree of freedom – undamped and damped vibration-free vibration - forced vibration, introduction to multi degree of freedom systems.

References

1. Weaver, W., and Gere, J.M., Matrix Analysis of Framed Structures, CBS Publishers, 2004.
2. Wilbur, J. B., Norris, C. H., and Utku, S., Elementary Structural Analysis, McGraw-Hill, 2006.
3. Rajasekaran, S., and Sankarasubramanian, G., Computational Structural Mechanics, PHI, 2001.
4. Selvam, V.K.M, Elements of Matrix and Stability Analysis of Structures, Khanna Publishers,1998.
5. Reddy, C. S., Basic Structural Analysis, Tata McGraw-Hill, New Delhi, 2007.
6. Menon, D., Advanced Structural Analysis, Narosa publishers, India,2008.
7. Hibbler, R. C., Structural Analysis, Pearson Education, India, 2006.
8. Paz M., Structural Dynamics, CBS Publishers, New York, 2007.
9. Clough, R. W and Penzien, J., Dynamics of Structures, McGraw Hill, 1993.

CE4003D WATER RESOURCES ENGINEERING II

Pre-requisites: CE2006D Open Channel Hydraulics and Hydrology

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:
CO1: Perform planning and investigation for siting reservoirs.
CO2: Perform preliminary analysis and design of gravity dams.
CO3: Perform preliminary analysis and design of hydropower structures.
CO4: Perform flood routing studies, dam breach analysis and flood frequency analysis.

Module 1: (15 hours)

Reservoirs

Reservoirs - Types of reservoirs, Investigations for reservoir planning, Site selection, Zones of storage, Reservoir yield, Mass curve, Determination of reservoir capacity and safe yield from a reservoir, single and multipurpose projects, reservoir losses and control, reservoir sedimentation and control, useful life of a reservoir.

Dams

Dams - Types of dams, Factors influencing selection of the type of dam and site, investigations. Gravity dams – forces and load combinations for design, modes of failure and stability requirements, elementary and practical profiles, joints, keys, water stops, openings and galleries, temperature control and foundation treatment. Arch dams – types, forces, and preliminary design.

Module 2: (14 hours)

Hydropower

Conventional and non-conventional energy sources, Classification of hydroelectric power plants, Comparison of hydropower with other sources of power, Status of hydroelectric power development in the world and in India, Terminology, Components of a typical hydropower plant, Storage and pondage, Flow duration curve, Firm and secondary power, Load factor and capacity factor, Water hammer and cavitation, Penstock, Surge tanks

Hydraulic Machines

Turbines - Classification, components, efficiency and work done – Pelton, Francis and Kaplan turbines, Draft tube theory, Specific speed, Selection of suitable types of turbines

Pumps – Classification, Reciprocating pumps – types – work done – effect of acceleration and frictional resistance, slip, coefficient of discharge – Rotodynamic pumps – types, advantages – working – volute and whirlpool chambers – velocity triangles of pumps – specific speed – general principle and working of deep well pumps

Module 3: (10 hours)

Floods and Water Excess Management

Determination of the design storm and the design flood hydrograph, Estimation of flood peak by rational and empirical methods, Flood frequency analysis, Standard Project Flood and Probable Maximum Flood, Hydraulics of excess water management, Approximate models, Flow routing – storage and channel routing, dam break problem.

References:

1. Modi, P. N., Irrigation, Water Resources, and Water Power Engineering, Standard Book House, 2011.
2. Garg, S. K., Irrigation Engineering and Hydraulic Structures: Water Resources Engineering - Vol. II, Khanna Publishers, 2017.

3. Dandekar, M. M. and K. N. Sharma, Water Power Engineering, Vikas Publishing House, 2013.
4. Subramanya, K., Hydraulic Machines, McGraw Hill Education, First edition, 2017
5. Ven T. Chow, David Maidment and Larry W Mays, Applied Hydrology, McGraw-Hill, Indian edition, 2017.
6. Subramanya, K., Engineering Hydrology, Tata McGraw- Hill Publishers, New Delhi, 2008.
7. Mays, L. W., Water Resources Handbook, McGraw-Hill International Edition, 1996.

CE4004D CONSTRUCTION MANAGEMENT AND QUANTITY SURVEYING

Prerequisite: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course outcomes:

The students will be able to:

CO1: Use of CPM and PERT for planning and managing construction activities

CO2: Prepare detailed estimates for buildings and water supply works

CO3: Understand various aspects of tendering, contract, project evaluation and control.

CO4: Prepare specifications for common construction materials and items of work as per IS.

CO5: Prepare reports on valuation of properties.

Module 1: (15 hours)

Construction Management: Network techniques – Introduction, Bar charts , use of CPM and PERT for planning , time estimates ; Critical path ; Updating ; Crashing ; Resource smoothing; Resource levelling; Computer applications.

Construction Planning: Preparation of job layout; Labour schedule, material schedule, equipment schedule

Module 2: (15 hours)

Quantity Surveying : Preparation of detailed estimates for buildings , reinforced concrete structures, sanitary and water supply works; Preparation of specification for common materials of construction and items of work as per IS ; Analysis of rates and preparation of abstract of estimate.

Module 3: (9 hours)

Project Execution and Monitoring : Tendering , contract , contract documents, measurements, types of contracts; Inspection and quality control ; Standardization ; Organizations at national and international level (BIS and ISO); Role of certification ; Introduction to valuation of real properties-Depreciation, Sinking fund , methods of valuation

References:

1. Wiest J.D. and Levy F.K., A Management Guide to PERT/CPM, Prentice-Hall, 2007
2. Srinath L.S., PERT and CPM – Principles and Applications, East-West Press, 2001
3. Jeffry K Pinto, Project Management - Achieving competitive Advantage, Pearson Publication, 2009
4. Peurifoy R. and Clifford J Schexnayder., Construction Planning, Equipment and Method, McGraw Hill, 2013.
5. Punmia B.C., Project Planning and Control with PERT and CPM, Laxmi Publications, 2016.
6. Dutta B. N., Estimation and Costing in Civil Engg, UBSPD, 1992.
7. Chakrabarthi, Estimation, Costing, Specification in Civil Engg, , 1982.
8. Shah, N. A., Quantity Surveying and Specification in Civil Engg., 1981.
9. I.S 1200 (1968), Methods of Measurement of Building and Civil Engg. Works
10. Mahajan, S. P., Civil Estimating and Costing, Sathyaprakasham, 1988.

CE4091D ENVIRONMENTAL ENGINEERING LAB

Pre-requisites:CE3009D Environmental Engineering I

L	T	P	C
0	0	3	2

Total hours: 39

Course Outcomes:

The students will be able to:
CO1: Carry out the analysis of water for pollutants
CO2: Advice on the suitability of water for various uses
CO3: Determine the optimum dosage of alum to be added to water for coagulation
CO4: Advice on water sampling& analysis protocols
CO5: Demonstrate knowledge in instrumental techniques used for water and air quality measurement.

List of experiments:

1. Determination of solids (total, dissolved, organic, inorganic and settleable) in water
2. Determination of turbidity and the optimum coagulant dose
3. Determination of alkalinity and pH of water
4. Determination of hardness and chlorides in water
5. Determination of iron and manganese in water
6. Determination of sulphates and sulphides in water
7. Determination of D.O and B.O.D of waste water
8. Determination of available chlorine in bleaching powder and the chlorine dose required to treat the given water sample
9. Determination of coliforms in water
10. Demonstration of instrumental methods of pollution analysis- UV- Visible, AAS, FTIR, TOC Analyser, Digital Sound level meter

References:

1. E.W. Rice, R.B. Baird, A.D. Eaton (Ed.) Standard Methods for the Examination of Water and Wastewater (23rd Edition), American Water Works Association,/American Public Works Association/Water Environment Federation, 2017.
2. Relevant BIS codes

CE4092D SEMINAR

Pre-requisites: Nil

L	T	P	C
0	0	2	1

Total hours: 28

Course outcomes:

The students will be able to:

CO1: Identify current trends and topics of relevance in Civil Engineering

CO2: Develop the ability of data collection on a specific topic and documenting the relevant details in a given format

CO3: Develop presentation skills for effectively conveying the subject matter to an audience

Individual students will be asked to choose a topic in any field of Civil Engineering, preferably from outside the B.Tech. syllabus and give seminar on the topic for about thirty minutes. A committee consisting of at least two faculty members specialized on different fields of engineering will assess the presentation of the seminars and award the marks to the students. Each student will be asked to submit two copies of a write up of the seminar talk –one copy will be returned to the student after duly certifying by the Chairman of the assessing committee and the other copy will be kept in the departmental library.

CE4098D PROJECT: PART 1

Pre-requisites: Nil

L	T	P	C
0	0	2	3

Total hours: 84

Course outcomes:

The students will be able to:

CO1: Build professional competence and confidence in students to take up civil engineering assignments

CO2: Identify the needs and requirements of a specific civil engineering task

CO3. Plan and design the task at hand with the help of appropriate conventional and modern methods/tools

CO4. Prepare professional documentation for the work carried out

The project work will be a design project –experimental project –field surveying or computer oriented on any of the topics of civil engineering interest.The assessment of the project will be done at the end of the semester by a committee consisting of three or four faculty members specialized in various fields of Civil Engineering. The students will present their project work beforethe committee. The complete project report is not expected at the end this semester. However a six to ten page typed report based on the work done will have to be submitted by the students to the assessing committee. The project guides will award the grades to the individual students depending on the group average awarded by the committee.

CE4099D PROJECT: PART 2

Pre-requisites: CE4098D PROJECT: PART 1

L	T	P	C
0	0	10	5

Total hours: 140

Course outcomes:

The students will be able to:

CO1: Build professional competence and confidence in students to take up civil engineering assignments

CO2: Identify the needs and requirements of a specific civil engineering tasks

CO3: Plan and design the task at hand with the help of appropriate conventional and modern methods/tools

CO4: Prepare professional documentation for the work carried out

The project work started in the seventh semester will continue in this semester. The students will complete the project work in this semester and present it before the assessment committee. The assessment committee as constituted in the seventh semester will assess the various projects for the relative grading and group average. The guides will award the grades for the individual students depending on the group average. Each group will submit the copies of the completed project report signed by the guide to the department. The head of the department will certify the copies and return them to the students. One copy will be kept in the departmental library.

CE3021D STATISTICS, PROBABILITY AND RELIABILITY METHODS IN ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Identify various sources of uncertainties associated with civil engineering

CO2: Enable the students to quantify and if possible to remove such uncertainties

CO3: Perform a probabilistic analysis of a civil engineering system

CO4: Determine the reliability of a civil engineering system under uncertain environment

Module 1: (14 hours)

Role of Probability in Engineering: Data Deduction. Basic Probability Concepts, Sample space and events, probability measure, mathematics of probability, theorem of Total Probability, Bayes' Theorem.

Random variables: Probability distribution of a random variable, multiple random variables, main descriptors of a random variable – Moments, expectation, covariance, correlation, conditional mean and variance.

Functions of Random variables: Expectation of a function of a random variable, derived probability distributions, approximate moments and distributions of functions.

Module 2: (12 hours)

Common Probabilistic Models: Models from Simple Discrete Random trails, Models from Random occurrences, Models from limiting cases, other commonly used Distributions, Multivariate Models.

Estimating Parameters from observed Data: Classical Approach to Estimation of Parameters.

Empirical Determination of Distribution Model: Probability paper, testing validity of Assumed Distribution. Regression and Correlation Analyses.

Module 3: (13 hours)

Reliability and Reliability Based Design: Reliability of engineered system, Analysis and Assessment of Reliability, Monte Carlo Method, Second Moment Formulation, Probability Based Design Criteria.

Introduction to Reliability of Structural Systems: System Reliability, Series Systems, Parallel Systems, Mixed systems.

References:

1. Ang, A. H. S and Tang, W. H., Probability Concepts in Engineering Planning and Design Vol. I Basic Principles, John Wiley and Sons, 1975.
2. Ang, A. H. S and Tang, W. H., Probability Concepts in Engineering Planning and Design Vol. II Decision, Risks and Reliability, John Wiley and Sons, 1984.
3. Jack R. Benjamin and C. Allin Cornell., Probability, Statistics and Decision for Engineers, McGraw-Hill, 1970.
4. Papoulis, A., Probability, Random Variables and Stochastic Processes, McGraw Hill, 2004.
5. Ranganathan, R., Reliability Analysis and Design of Structures, Tata McGraw Hill, 1990
6. Madsen, H. O., et al, Methods of Structural Safety, Prentice-Hall,1986.
7. Melchers, R. E., Structural Reliability - Analysis and prediction, Ellis Horwood Ltd, 1987

CE3022D CONCRETE TECHNOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:
CO1. Select suitable materials for cement concrete construction.
CO2. Design a concrete mix proportion based on the requirements and make a proper concrete for construction purposes.
CO3. Determine the hardened properties of concrete and make a durable concrete.
CO4. Suggest suitable type of special concrete and diagnose the distress in concrete structures and apply remedial measures.

Module 1 (13 hours)

Materials: cement - different types ,chemical composition and physical properties ; tests on cement , I.S. specifications ; Aggregates - classification ,mechanical properties and tests as per I.S. , grading requirements , Sampling of aggregate ; Water - quality of water , permissible impurities as per I.S ; Admixtures - accelerators , retarders , water reducing agents , super plasticizers;

Concrete: Manufacture of concrete, measurement of materials, storage and handling, batching plant and equipment mixing - types of mixers , transportation of concrete , pumping of concrete , placing of concrete , under water concreting , compaction of concrete , curing of concrete , ready mixed concrete**.**

Module 2 (13 hours)
Properties of concrete :Fresh concrete - workability , tests for workability , cohesion , segregation and bleeding ; Hardened concrete- factors affecting strength of concrete , strength of concrete in compression, tension and flexure ; stress- strain characteristics and elastic properties ;
Durability of concrete: Creep and Shrinkage; Permeability ; Chemical attack ; Sulphate attack , Alkali – silica reaction ; Alkali -aggregate reaction ;Resistance to abrasion and cavitaion ; Resistance to freezing and thawing ; Resistance to fire ; Marine atmosphere , quality control ; Frequency of sampling , test specimens , statistical analysis of test results ; standard deviation ; Acceptance criteria

Module 3 (13 hours)
Special concrete : Light weight concrete ,High strength concrete; High performance concrete; Fibre reinforced concrete-polymer concrete ; Ferro cement; Self compacting concrete ; Types of failure ; Diagnosis of distress in concrete ; Crack control, leak proofing ; Shotcrete ; Guniting and jacketing techniques ; Mix design - nominal mixes and design mixes , factors influencing mix design ; ACI method and I.S method , design for high strength mixes

References:

1. Neville, A. M., Properties of Concrete, Pitman, 1987.
2. P. Kumar Mehta, Concrete: Microstructure, Properties, and Materials, McGraw-Hill,2005
3. Shetty, M. S., Concrete Technology, S I Chand and Company, 1993.
4. Gambhir, M. L., Concrete Technology, Tata McGraw Hill, 1995.
5. Orchard, D. F., Concrete Technology Vol. I and II, 1968.
6. Krishna Raju, N., Design of Concrete Mixes, CBS publishers, 1988.
7. Raina, V. K., Concrete for Construction-Facts and Practices, Tata McGraw Hill publishing co. 1988.
8. John. H. Bungey, The Testing of Concrete in Structures, Urrey University of Press Hall
9. Akroyd, T. N. W., Concrete: Properties and Manufacture, Pergamon Press, 1962.

CE3023D GROUND IMPROVEMENT

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

The students will be able to:
CO1: Familiarize with various ground improvement techniques
CO2: Design suited to site conditions
CO3: Take decision in selecting improvement techniques
CO4: Design geotextiles applications in pavements

Module 1: (12 hours)

Introduction to soil improvements without the additives - dynamic compaction - equipment used - application to granular soils - cohesive soils - depth of improvement - environmental considerations - induced settlements - compaction using vibratory probes - vibro techniques vibro equipment - the vibro compaction and replacement process - control of verification of vibro techniques - vibro systems and liquefaction - soil improvement by thermal treatment - preloading techniques - surface compaction introduction to bio technical stabilization

Module 2: (14 hours)

Introduction to soil improvement by adding materials - lime stabilization - lime column method - stabilization of soft clay or silt with lime - bearing capacity of lime treated soils - settlement of lime treated soils - improvement in slope stability - control methods –lime fly ash columns- chemical grouting - commonly used chemicals - grouting systems - grouting operations - applications - compaction grouting - introduction - application and limitations - plant for preparing grouting materials - jet grouting - jet grouting process - geometry and properties of treated soils - applications - slab jacking - gravel - sand - stone columns- design and construction techniques

Module 3: (13 hours)

Soil improvement using reinforcing elements - introduction to reinforced earth - load transfer mechanism and strength development – Design techniques - anchored earth nailing reticulated micro piles - soil dowels - soil anchors - reinforced earth retaining walls; Geotextiles - polymer type geotextiles - woven geotextiles - non woven geotextiles - geo grids - physical and strength properties - behaviour of soils on reinforcing with geotextiles - effect on strength, bearing capacity, compaction and permeability - design aspects – Design of PVD-slopes - clay embankments - retaining walls – pavements

References:

1. Michael P. & Moseley, Ground Improvement, second edition, CRC Press, 2004
2. Klaus Kirsch, & Alan Bell, Ground Improvement, third edition, CRC Press, 2012
3. Boweven, R., Text Book on Grouting in Engineering Practice, Applied Science Publishers Ltd, 1975.
4. Jewell, R. A., Text Book on Soil Reinforcement with Geotextiles, CIRIA Special Publication, Thomas Telford, 1996.
5. Van Impe, W. E., Text Book On Soil Improvement Technique and Their Evolution, Balkema Publishers, 1989
6. Donald.H. Gray and Robbin B. Sotir, Text Book On Bio-Technical and Soil Engineering Slope Stabilization, John Wiley, 1996
7. Rao, G. V. and Rao, G. V. S., Text Book On Engineering With Geotextiles, Tata McGraw Hill, 1990
8. Korener, Construction and Geotechnical Methods In Foundation Engineering, McGraw Hill, 2005
9. Shashi K.Gulhati and Manoj Datta , Geotechnical engineering, Tata McGraw Hill, 2008

CE3024D REINFORCED EARTH AND GEOTEXTILES

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:
The students will be able to:
CO1: Familiar with reinforced earth and its applications
CO2: Design embankment designs based on earth reinforcing techniques
CO3: Take decision in selecting reinforcing techniques
CO4: To design impermeable barriers

Module 1: (13 hours)

Reinforced Earth – The mechanisms of the reinforced earth techniques – Design principles – Materials used for construction – Advantages of reinforced earth – Reinforced earth construction techniques-An overview of Geosynthetics, Description of Geotextiles – Geogrids – Geonets – Geomembranes – Geocomposites – Geocells

Module 2: (13 hours)

Designing with Geotextiles – Geotextile properties and test methods – Functions of Geotextile – Design methods for separation – stabilization – filtration – Drainage; Designing with Geogrids – Geogrid properties and test methods – Designing with Geonets – Geonet properties and test methods – Designing with Geomembranes – Geomembrane properties and test methods – construction practices with Geotextiles, Geogrids, Geonets, Geomembranes

Module 3: (13 hours)

Design of liquid Contaminant liners – liquid contaminant liners – Covers for reservoirs- Water conveyance (Canal liners)-- solid material liners – underground storage tanks – Design of pavements – Geo composites as liquid / Vapour Barriers –Improvement in bearing capacity – Erosion Control for water ways

References:

1. Robert M. Koerner, Designing with Geosynthetics, 6th edition, Xlibris Pub., 2012
2. Rao, G. V., and Suryanarayana Raju, G. V. S., Engineering with Geosynthetics, Tata Mc Graw Hill Publishing Co. New Delhi, 1990
3. Shukla, S. K., Geosynthetics and their Applications, Thomas Telford, London,2002

CE3025D EARTH AND EARTH RETAINING STRUCTURES

L	T	P	C
3	1	0	3

Pre-requisites: CE3004D Geotechnical Engineering II

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Familiarize with earth pressure theories

CO2: Do designs based on earth pressure

CO3: Take decision in selecting type of retaining structures

CO4: Familiarize with slope stability analysis

Module 1: (13 hours)

Earth dams – types of dams – selection of type of dam based on material availability – foundation conditions and topography Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope protection – central and inclined cores – types and design of filters Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation-Stability analysis – critical stability conditions – evaluation of stability by Bishop‘s and sliding wedge methods under critical conditions Construction techniques – methods of construction – quality control Instrumentation – measurement of pore pressures

Module 2: (14 hours)

Earth pressure theories – Rankine‘s and Coulomb‘s earth pressure theories for cohesionless and cohesive backfills – computation of earth pressures for various cases – inclined – with surcharge – submerged and partly submerged – stratified backfills; Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Surcharge - computation of earth pressures by Trial wedge method – a mathematical approach for completely submerged and partly submerged backfills – importance of capillarity tension in earth pressure. Graphical methods of earth pressure computation – trial wedge method for coulomb‘s and Rankine‘s conditions, for regular and irregular ground and wall conditions – Rebhan‘s construction for active pressure – friction circle method – logarithmic spiral method. Design of gravity retaining wall – cantilever retaining walls

Module 3: (12 hours)

Flexible retaining structure – type and methods of construction – design strength parameters – safety factor for sheet pile walls – computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – anchored sheet piles – free earth method – fixed earth method – Rowe‘s moment reduction method – stability of sheet piling Diaphragm walls and coffer dams – type of diaphragm walls and their construction techniques in various soil types – earth pressure on braced cuts and coffer dams – design of coffer dams

References:

1. Clayton, Milititsky and Woods, Earth Pressure And Earth-Retaining Structures, Taylor and Francis, 1996
2. Tschebotarioff G P, Foundations, Retaining and earth structures, 2nd edition, Mcgraw Hill Pub., 1973
3. Huntington, Earth pressure on retaining walls, John Wiley and Sons, 1957
4. Bowles, Foundation Analysis and Design, 1968.
5. Jones, Earth Reinforcements and Soil structures, 1996
6. Prakash, Ranjan and Saran, Analysis and Design of Foundations and Retaining structures,Saritha Prakashan, Meerut, 1977

CE3026D ENVIRONMENTAL GEOTECHNICS

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Familiarize with contaminant transport mechanisms

CO2: Do designs of waste disposal units

CO3: Learn techniques to monitor, to maintain waste disposal units

CO4: Familiarize with various soil remediation techniques

Module 1: (13 hours)

Introduction to environmental geotechnology –Regulatory requirements Basic soil mineralogy: structural units of soil - Clay mineral structures - Identification and determination of clay minerals - Particle bonds, bond energies and linkages, Ion exchange reaction and capacity- Hydrophilic and hydrophobic soils. Soil water interaction: Introduction – Electrochemical characteristics of soil water system - Soil water interaction in the thermal energy field – Geomorphic process in soil – effect of bacteria on behaviour of soil water system –Sensitivity of soil to environment. Introduction to Hydrogeology – Hydraulic conductivity – Infiltration, percolation, retention and recharge – Flow in unsaturated soils – Flow in saturated soils, Geo chemistry – Geochemical attenuation, Ground water monitoring techniques-Sources and types wastes - Waste characteristics - Objectives of waste disposal facilities Contaminant transport – Transport process: diffusion, dispersion, advection – Dispersion: analytical solutions

Module 2: (14 hours)

Landfills and surface impoundments: – Types, components and requirements of landfills - siting of landfills – Various end uses of closed landfills - Landfill microbiology – Microbiology of refuse composition- Leachate and gas generation - Primary and Secondary leachate - Leachate collection and removal systems -Gas collection and removal systems – Impact of hazardous waste on leachate and gas characteristics-Liners – Natural clay liners – compacted clay liners – requirements of clay liners – Geo synthetic clay liners – Geomembrane liners - Specifications of liners in hazardous wastes landfills – Quality control of liners- Design of liners. Design of Cover systems – Recovery well design

Module 3: (12 hours)

Geophysical techniques for site characterization – Sampling – Testing of samples - Slope stability analysis of landfills – Water balance for landfills Soil remediation technologies: Soil washing – Electrokinetic remediation - Soil vapor Extraction - Soil Vapor Extraction – Bioremediation - Stabilization and Solidification. Groundwater remediation technologies: Pump and Treat - In-Situ Flushing - Bioremediation. Mine waste disposal systems

References:

1. David. E. Daniel, Geotechnical practice for waste disposal – Chapman and Hall – London, 1993.
2. Masashi Kamon, editor – Balkema, Environmental Geotechnics, - Rotterdan 1996
3. Hsai- Yang Fang, Introduction to Environmental Geotechnology,- CRC Press, New York, 2009

CE3027D WATER CONVEYANCE SYSTEMS

Pre-requisites: CE2006D Open channel Hydraulics and Hydrology

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Understand basic hydraulic principles governing analysis of flow in water distribution systems

CO2: Analyse water distribution networks

CO3: Perform design of mobile and rigid boundary channels

CO4: Analyse flow transients in water conveyance systems

CO5: Design on farm irrigation systems

Module 1 (14 hours)

Conservation laws - mass, momentum and energy.Governing equations of fluid flow, initial and boundary conditions. Pipe flow - review of basic hydraulic principles of analysis and design of pipelines, losses in pipelines, pumping and gravity mains, economic analysis for pipe choice, pipe materials, specification for pipes, pipe appurtenances, design principles - internal pressures and external loads, analysis of distribution networks - Hardy Cross, equivalent pipe and Newton Raphson methods, computer applications in distribution network analysis, components and maintenance of distribution networks, methods of control and prevention of corrosion.

Module 2 (13 hours)

Open channel flow - canal network and hierarchy of canals, afflux and energy loss, design of erodible and lined channels for clear and sediment-laden flows - CBI & P method, tractive force method, regime methods. compound channels, channel networks, spatially varied flow, energy dissipators, and channel transitions, unsteady flow, dam break analysis.

Flow distribution control in canals, decentralised control, canal automation - purpose and selection of scheme, automation application, hardware and software components in automation systems, a typical automation system.

Module 3 (12 hours)

Flow Transients - Surges and water hammer, Causes, problems and protection
Design of on-farm irrigation systems.

References:

1. Thomas. M. Walski, Donald. V. Chase, Dragan. A. Savic, Water Distribution Modeling, Haestad Press, 2001.
2. Thomas. M. Walski, Donald. V. Chase, Dragan. A. Savic, AdvancedWater Distribution Modeling and Management, Haestad Press, 2001.
3. Prabhata. K. Swamee and Ashok. K. Sharma, Design of Water Supply Pipe Networks, Wiley-Interscience, 2008.
4. Nemanja Trifunovic, Introduction to Urban Water Distribution, CRC Press, 2006.
5. P. R. Bhave and R. Gupta., Analysis of Water Distribution Networks, Alpha Science, 2006.
6. Ven Te Chow, Open Channel Hydraulics, Mc Graw Hill Inc.
7. Richard. H. French, Open Channel Hydraulics, Water Resources Publications, 2007.
8. Le Anh Tuan, Open Channel Hydraulics for Engineers, Lambert Academic Publishing, 2011
9. Roland Jeppson, Open Channel Flow: Numerical Methods and Computer Applications, CRC Press, 2010.
10. Terry. W. Sturm, Open Channel Hydraulics, Mc Graw Hill In., 2009.
11. Larry. G. James, Principles of Farm Irrigation System Design, Krieger Publishing Co., 1993.
12. Larry. E. Keesen, The Complete Irrigation Workbook, Create Space, 2013.

13. Glenn. J. Hoffman et. al., Design and Operation of Farm Irrigation Systems, ASAE, 2007.
14. Rajesh Srivastava, Flow through Open Channels, Oxford University Press, 2008.
15. Jean-Jacques Goussard, Automation of Canal Irrigation Systems, ICID, 1993.
16. Canal Automation for Irrigation Systems, ASCE Manuals and Reports on Engineering Practice (MOP) 131, 2014.
17. E. Benjamin Wylie, and Victor. L. Streeter, Hydraulic Transients, Mc Graw Hill Inc., 1967.
18. M. Hanif Chaudhry,Applied Hydraulic Transients, Springer Verlag, 2014.
19. A. R. D. Thorley, Fluid Transients in Pipeline Systems, Wiley, 2004.

CE3028D HYDRAULIC MACHINERY

Pre-requisites: CE2002D Mechanics of Fluids

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
The students will be able to:
CO1: Compute the dynamic thrust exerted by a fluid jet on stationary and moving surfaces
CO2: Select the appropriate turbine depending on the field situation and design the same
CO3: Design protection systems for the conveyance systems in power plants
CO4: Select the appropriate pump depending on the field situation and design the same
CO5: Understand the working principle of other commonly used hydraulic machines

Module 1 (14 hours)

Classification of hydraulic machines, Dynamic thrust of a jet on fixed and moving surfaces - Work done and efficiency.

Turbines – Introduction, Classification.Pelton wheel turbine – General description, Work done and efficiency, Working proportions, Multiple jet Pelton Wheel, Design.Francis turbine - General description, Work done and efficiency, Working proportions, Design, Draft tubes, Types of draft tubes.Kaplan turbine - General description, Working proportions, Design.Governing of turbines, Performance Characteristics, Selection of turbines, Runaway speed, Surge tanks.

Module 2 (13 hours)

Pumps – Introduction and classification.Reciprocating pumps – General description, Work done, Single acting and double acting types, Indicator diagram - theoretical and modified for the effect of acceleration and friction in pumps, Air vessels, Multi cylinder pumps.Centrifugal pumps – General introduction, Comparison with displacement type pump, Work done, Head and Efficiency, Net positive suction head, Specific speed, Model testing, Cavitation, Performance characteristics, Multistage pumps, Selection and installation, Operation and maintenance, Trouble shooting in centrifugal pumps.

Module 3 (12 hours)

Others types of pumps in common use – General description, Characteristics, Design, Selection, Installation, Troubles and remedies in the case of deep well turbine and submersible pumps, Propeller - mixed flow and jet pumps.Other hydraulic machines.

References :

1. Michael,A. M., and S. D. Khepar, Water Well and Pump Engineering, Tata McGraw Hill Public. Company, New Delhi, 2008.
2. Modi, P. N., and S.M. Seth, Hydaulics and Fluid Mechanics including Hydraulic Machines, Standard Book House, New Delhi, 2013.
3. Jagadish Lal, Fluid Mechanics and Hydraulic Machines, Standard Book House, New Delhi, 2005.
4. S. K. Som, Gautam Biswas, and S. K. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill, 2017.
5. K. Subramanya, Fluid Mechanics and Hydraulic Machines: Problems and Solutions, Tata McGraw Hill, 2010.

CE3029D REMOTE SENSING AND GIS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Understand the principles of remote sensing and select appropriate remote sensing data for intended application.

CO2: Perform digital image analysis to extract data from the remote sensing images.

CO3: Understand the principles of GIS and basic GIS operations to perform spatial analysis.

CO4: Apply remote sensing and GIS techniques for solving problems in different areas of engineering.

Module 1: (13 hours)

Remote Sensing Concepts

Concepts and foundations of remote sensing- Energy sources and radiation principles- Energy interactions in the atmosphere – Energy interaction with earth surface features - Spectral reflectance of vegetation, soil and water - Atmospheric influence on spectral response patterns

Remote Sensing Satellites

Remote sensing platforms – Sun synchronous systems- Geosynchronous systems-Across track and along track scanning systems – Types of sensor resolutions (Spatial, Spectral, Radiometric and Temporal resolution) – Mutispectral and thermal scanners – Characteristics of Remote sensing satellites and sensors (IRS, Landsat, SPOT, IKONOS)

Module 2: (13 hours)

Satellite Image Interpretation

Visual Image Interpretation – Standard False Colour Composites – Elements of visual image interpretation

Digital Image Analysis

Digital Image Processing – Storage formats (BSQ, BIL, BIP) – Sources for Geometric and Radiometric distortions in images – Image rectification and restoration – Image histogram – Image enhancement – level slicing, contrast stretching, convolution filtering, Band ratioing (NDVI) – Image classification – Supervised classification algorithms – Accuracy assessment – land use/ land cover mapping

Module 3: (13 hours)

Concepts of GIS

GIS - Definition, Spatial and attribute data, Components of GIS, DBMS – Geospatial data representation (Raster, Vector) -Sources of GIS data – Data input - Raster geospatial data analysis - Output functions of raster geoprocessing – Vector GIS analysis functions - Vector geoprocessing output functions

Applications

Application of Remote Sensing and GIS with specific reference to hydrological modelling and watershed management, urban growth and transportation planning, disaster mitigation and management

References:

1. Thomas. M. Lillesand, Ralph. W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation , John Wiley and Sons, Inc., Sixth Edition, 2011
2. John R. Jenson, Remote Sensing of the Environment: An Earth Resource Perspective, Pearson Education India, Second edition, 2013
3. George Joseph, Fundamentals of Remote Sensing, Universities Press, Second edition, 2005
4. John A. Richards and Xiuping Jia, Remote Sensing Digital Image Analysis: An Introduction, Springer (Sge), Fourth Edition, 2008
5. Lo C. P and K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Pearson Education, Second edition, 2016

CE3030D GROUNDWATER HYDROLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:

CO1: Identify the geologic formations capable of storing and transporting groundwater

CO2: Carry out test to determine aquifer parameters and analyse data from pumping tests

CO3: Evaluate the risk of contaminated water and suggest remedial measures

CO4: Understand how groundwater models can be applied to solve engineering problems

Module 1: (10 hours)

Ground water and hydrologic cycle, origin of ground Water, vertical distribution of ground water, zone of aeration and zone of saturation, geologic formation as Aquifers, types of aquifers, porosity, Specific yield and Specific retention. Permeability, Darcy's law, storage coefficient, Transmissivity, Heterogeneity and Anisotropy, Direct and indirect methods for estimation of aquifer parameters, Governing equation for flow through porous medium, Steady and unsteady state flow - Initial and boundary conditions

Module 2: (10 hours)

Steady flow ground water flow towards a well in confined and unconfined aquifers-Dupit's and Theim's equations, Assumptions, Formation constants, yield of an open well interface and well tests. Unsteady flow towards a well — Non equilibrium equations-Thesis solution-Jacob and Chow's simplifications, Partially penetrating wells - Wells in a leaky confined aquifer - Multiple well systems - Wells near aquifer boundaries.

Module 3: (10 hours)

Groundwater transport process, Advection, diffusion, dispersion, Hydrodynamic dispersion advection dispersion equation and parameters - initial and boundary conditions - method of solutions. Saline Water Intrusion In aquifers: Occurrence of saline water intrusions, Ghyben-Herzberg relation, Shape of interface, control of seawater intrusion.

Module 4: (9 hours)

Groundwater modeling, analytical and numerical approaches for the solution of groundwater flow and transport problems, model construction using MODFLOW and MT3D, Case studies, dewatering problems, Contaminant transport case studies.

References:

1. D.K. Todd and L. Mays, Groundwater hydrology. New York: John Wiley & Sons, 2005.
2. A. K. Rastogi, Numerical Groundwater Hydrology. Penram International Publishing (India), Pvt. Ltd., 2011.
3. H. M. Raghunath, Groundwater, 3rd ed. New Age International (P) Ltd, 2007.
4. C. W. Fetter, Applied Hydrogeology. Essex: Pearson Education, 2014.
5. C.W. Fetter, Contaminant Hydrogeology. Upper Saddle River, N.J: Prentice Hall, 1999
6. C. Zheng and G. Bennett, Applied Contaminant Transport Modeling. New York: Wiley-Interscience, 2002.
7. N. Kresic, Hydrogeology and Groundwater Modeling, Second Edition. Hoboken: CRC Press, 2006.
8. V. Batu, Applied Flow And Solute Transport Modeling In Aquifers. Boca Raton, FL: Taylor & Francis, 2006.

CE3031D FINITE ELEMENT METHOD IN FLUID FLOW

Pre-requisites: CE2002D Mechanics of Fluids or Equivalent Course

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The Students are able to:

CO1: Formulate and solve finite element models for flow analysis.

CO2: Perform linear and nonlinear analysis of pipe networks.

CO3: Perform two dimensional flow analysis.

CO4: Familiarize with isoparametric formulation and numerical integration.

Module 1: (13 hours)

Review of Basic Equations of Fluid Mechanics and Pipe Network Analysis, Linear finite element analysis of pipe networks, total system of equations, boundary conditions, solution of system of equations, non-linear analysis of pipe networks, computer algorithms for linear and non-linear analyses.

Module 2: (13 hours)

One Dmensional Flow Analysis, Interpolation functions, C^m continuity. Governing differential equations, finite element formulations and solutions for (i) laminar flow through pipes, (ii) viscous flow on an inclined flat surface, and (iv) radial flow in an unconfined aquifer.

Isoparametric formulation.Numerical integration.Transformation of velocity, stress rates, and stiffness matrix.

Module 3: (13 hours)

Potential Flow Analysis, Euler's equation of motion, stream function formulation, potential function formulation, finite element solution of groundwater flow and flow around a cylinder. Finite element solution of Navier-Stokes equations using stream function and vorticity formulation.

References:

1. Reddy, J. N., An Introduction to the Finite Element Method, McGraw Hill Book Co; 1993.
2. Rao, S. S., The Finite Element Method in Engineering, Elsevier, 2004.
3. Zienkiewicz, O. C., and K. Morgan, Finite Elements and Approximation, John Wiley and Sons, 1983.
4. Zienkiewicz, O. C., R.L. Taylor, and J. Z. Zhu, The Finite Element Method –Its Basics and Fundamentals, Elsevier, 2005.

CE3032D STATISTICAL TECHNIQUES IN WATER RESOURCES ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to

CO1: Perform probabilistic analysis of problems in water resources engineering.
CO2: Identify the suitable probability distribution and estimate parameters of hydrologic random variables.
CO3: Establish the statistical relationship between the variables.

Module 1: (9 hours)

Randomness of hydrologic variables – total probability and Bayes theorems.Univariate, bivariate, marginal and conditional distributions of hydrologic random variables. Independence. Derived and mixed distributions.Properties of hydrologic random variables – moments and expectation, moment generating functions.Measures of central tendency, dispersion, symmetry, and peakedness. Moments and expectation of jointly distributed hydrologic random variables, covariance, correlation coefficient, parameter estimation, Chebyshev inequality.

Module 2: (11 hours)

Discrete Probability Distributions of Hydrologic Random Variables – hypergeometric distributions, Bernoulli process – binomial, geometric, and negative binomial distributions. Poisson process – Poisson, exponential, and gamma distribution, multinomial distribution. Continuous Probability Distributions of Hydrologic Random Variables – general and standard normal distributions, central limit theorem, constructing normal curves for hydrologic data, normal approximations of binomial, negative binomial, and Poisson distributions. Uniform, exponential, gamma, lognormal, extreme value, beta, and Pearson distributions.Chi-square, t-, and F-distributions.

Module 3: (9 hours)

Probability Plotting and Frequency Analysis –probability plotting, analytical hydrologic frequency analysis, regional frequency analysis, frequency analysis of precipitation data and other hydrologic variables.Linear and nonlinear regression, transformation of nonlinear models.Correlation, correlation and regional analysis.Multivariate analysis, principal component analysis, univariate and multivariate data generation.

Module 4: (10 hours)

Hydrologic time series – definition, autocorrelation, spectral analysis, applications of autocorrelation and spectral density functions in hydrology. Stochastic hydrologic models – purely random stochastic models, first order Markov process, first order Markov process with periodicity, higher order autoregression models, multisite Markov model, Markov chain models of hydrologic processes.

References:

1. C. T. Haan, Statistical Methods in Hydrology, Wiley-Blackwell; 2nd edition, 2002
2. M. Shahin, H. J. L.vanOorschot, and S. J. de Lange, Statistical Analysis in Water Resources Engineering, Aa-Balkema, Rotterdam, Brookfield, 1993
3. V. Yevjevich, Probability and Statistics in Hydrology, Water Resources Publications, Fort Collins, Colorado, USA, 2nd edition, 2010.
4. V. Yevjevich, Stochastic Processes in Hydrology, Water Resources Publications, Fort Collins, Colorado, USA, 1970.
5. P. Jayarami Reddy, A Text Book of Stochastic Hydrology,Laxmi Publications, New Delhi, 2nd edition, 2016.

CE3033D SOFT COMPUTING TECHNIQUES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Familiarize with soft computing concepts

CO2: Introduce the ideas of Support Vector Machines, Neural networks, Genetic algorithm, Fuzzy logic and Hybrid Systems

CO3: Apply the concepts of softcomputing techniques to civil engineering problems

Module 1: (9 hours)

Soft Computing: Introduction, requirement, different tools and techniques, usefulness and Applications, Support vector Machines (SVM) , Artificial Neural Networks, Biological neural networks, Model of an artificialNeuron, Comparison between biological neuron and artificial neuron, Basic models of artificial neural network, Learning methods, Hebb's learning, Adaline, Perceptron

Module 2: (9 hours)

Back propagation Networks : Architecture - Multi layer perceptron –Back propagation learning – Input layer, Hidden Layer , Output Layer computations, Calculation of error,Training of ANN, Back propagation Algorithm, Momentum and Learning rate, Selection of various parameters in BP networks- Radial Basis Function Networks, Applications of ANN in Civil engineering

Module 3: (9 hours)

Fuzzy sets and fuzzy logic, Fuzzy sets and crisp sets, ,Fuzzy set operations, Fuzzy relations, Membership functions, Features of the membership functions, Fuzzification, Defuzzification, Defuzzification methods, Fuzzy Rule Base andapproximate reasoning, Formation of rules, Decomposition of rules, Fuzzy Inference Systems, Construction and Working Principle of FIS, Methods of FIS, Mamdani FIS and Sugeno FIS, Application of FLC Systems in Civil engineering

Module 4: (12 hours)

Genetic Algorithms, Basic Concepts, Creation of off springs, Working Principle, Encoding, Fitness function, Reproduction, Roulette Wheel Selection, Boltzmann Selection, Tournament selection, Rank Selection, Steady State Selection, Elitism, operators in GA, Cross Over, Inversion and deletion, Mutation Operator, Bit wise operators, Convergence of Genetic Algorithm, Stopping Condition, Constraints in GA, Classification of GA, Advances in GA, ,Genetic Programming, Applications of GA in Civil Engineering

Hybrid Soft Computing Techniques, Neuro Fuzzy Hybrid Systems, Genetic Neuro Hybrid systems, Genetic fuzzy Hybrid and fuzzy genetic hybrid systems, Hybrid systems applications in Civil engineering

References:

1. F. Karray and C. De Silva, Soft computing and intelligent systems design, Theory, Tools and Application, Pearson Education, 2004.
2. S. Sivanandam and S. Deepa, Principles of soft computing. Wiley India Pvt Ltd, New Delhi: 2013.
3. D.E. Goldberg, Genetic Algorithms. Pearson Education India, 2006.
4. S. Haykin, Neural networks and learning machines. Upper Saddle River: Prentice Hall, 2009.
5. H. Zimmermann, Fuzzy set theory-and its applications. Boston: Kluwer Academic, 2014.
6. T. Ross, Fuzzy logic with engineering applications, 3rd ed. Wiley India, 2009.
7. S. Rajasekaran and G.A VijayalakshmiPai, Neural networks, fuzzy logic, and genetic algorithms-Synthesis and Applications, Prentice Hall of India, New Delhi: 2017.

CE3034D COASTAL ENGINEERING AND COASTAL ZONE MANAGEMENT

Pre-requisites: CE2002D MECHANICS OF FLUIDS

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Understand the basics of hydrodynamics of ocean waves

CO2: Learn about methods of protecting the coast

CO3: Estimate long shore and cross shore transport

CO4: Compute wave forces on various coastal structures

CO5: Practice ICZM principles

Module 1: (14 hours)

Coastal Engineering – coastal environment and coastal zone, problems. Water level fluctuations – tides, surgesand seiches. Wave Mechanics – wave generation.Small amplitude wave theory - formulation and solution, wave celerity, length and period, classification of waves based on relative depth, orbital motions and pressure, standing waves, wave train and wave energy. Wave transformation – shoaling, reflection, refraction and diffraction, Breaking of waves. Finite Amplitude Waves – higher order wave theories such as Stokes wave theory, Cnoidal wave theory, trochoidal wave theory, solitary wave theory, and stream function wave theory. Numerical wave theory.Wave interaction with currents.Regimes of application of different wave theories.Tsunamis.

Module 2: (12 hours)

Causes of coastal erosion. Shore protection. Type of beaches.Methods of shore protection – structural and nonstructural methods.Coastal processes - long term and short term changes in the shoreline, cross shore and long shore currents, littoral drift, onshore-offshore movement of sediments, longshore transport, application of mathematical models, factors affecting equilibrium of beaches. Coastal erosion and protection along theKerala coast.Integrated coastal zone management (ICZM) - coastal resource planning and management, management goals and purposes, sustainable use of resources, application of IT in coastal zone management.Coastal ecosystems including mangroves, mudbanks.Legislation in India including the CRZ and CZMA Acts.

Module 3: (13 hours)

Short term and long term wave statistics. Wind generated waves – wave forecasting and wave hindcasting.

Wave structure interaction – Forces on shore structures due to breaking, broken and non-breaking waves.Design of rubble mound structures. Wave force on a circular (vertical, inclined and oscillating cylinder) - Morison equation, wave force on submarine pipelines.

References:

1. Arthur. T. Ippen (ed.), Estuary and Coastline Hydrodynamics, Mc Graw Hill Book Co., 1966.
2. Robert. M. Sorenson, Basic Coastal Engineering, Springer, 2006.
3. USACE, Coastal Engineering Manual Part. I to VI (Pub. No. EM 1110-2-1100), 2012.
4. J. S. Mani, Coastal Hydrodynamics, Prentice Hall India, 2011.
5. V. Sundar, Ocean Wave Mechanics, John Wiley & Sons Ltd., 2016.
6. D. Reeve, Andrew Chadwick, and Christopher Fleming, Coastal Engineering, Spon Press, 2004.
7. Kamphius, J. W., Introduction to Coastal Engineering and Management, World Scientific, 2010.
8. Dean, R. G., and R.A. Dalrymple, Coastal Processes with Engineering Applications, Cambridge University Press, 2004.

CE3035D TRANSPORTATION AND LANDUSE

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Describe the distinctive social, cultural, and spatial features of cities and illustratetheir impacts on the urban experience

CO2: Apply basic skills of empirical reasoning to solve urban problems.

CO3: Speculate on the range of processes which generate urban growth and its differentstructures.

CO4: Describe some of the zone based spatial statistical methods available to measureurban growth dynamics and patterns.

CO5: Formulate alternative plans for transport and land use development.

CO6: Evaluate the operational, environmental and economic impacts of transport and landuse.

Module 1: (9 hours)

Urban Forms and Urban Structure: Hierarchy of Urban Activity System, Hierarchy of Urban Transportation Network and Technology; Relationship between Movement and Accessibility Functions of Transportation Network; Urban Structure and its Characteristics such as Centripetal, Grid Iron, Linear and Directional Grid types, Study of Urban Forms such as Garden City, Precincts, Neighbourhoods, Linear City, MARS Plan, LeCorbusier Concept, Radburn Concept, Environmental Area Concept.

Module 2: (10 hours)

Demographic and Employment Forecasting Models: Demographic Models- Linear, Exponential and Logistic Models; Cohort Survival Models-Birth, Aging and Migration Models; Employment Forecasting Models- Economic base Mechanism; Population and Employment Multiplier Models - Input and Output Models - Dynamic Models of Population and Employment – Multiregional Extensions

Module 3: (10 hours)

Landuse-Transportation Models: Lowry based Landuse-Transportation Models – Allocation Function, Constraints, Travel Demand Estimation – Iterative Solutions, Matrix Formulation, Dynamic and Dis-aggregated extensions.

Module 4: (10 hours)

Evaluation of Landuse – Transportation Plans: Operational, Environmental and Economic Evaluation – Concept of Demand and Supply for Transportation Projects – Benefit and Cost – B/C and Cost Effective Approach for Economic Evaluation.

References:

1. Hutchinson B.G., Principle of Transportation Systems Planning, McGraw-Hill.
2. Oppenheim N., Applied Models in Urban and Regional Analysis, Prentice-Hall.
3. Dickey J.W., et. al., Metropolitan Transportation Planning, Tata McGraw-Hill.
4. Gallion A.B and Eisner S., The Urban Pattern, Affluated East-West Press, New Delhi.
5. ITE (1982), Transportation and Traffic Engineering Hand Book, Chapters 21 and 22', Prentice-Hall, New Jersy.
6. Wilson, A.G, Urban and Regional Models in Geography and Planning, John Wiley and Sons.

CE3036D TRANSPORTATION PLANNING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Design and conduct surveys to provide the data required for transportation planning.

CO2: Develop trip production and attraction models at different levels.

CO3: Calibrate trip distribution models and modal split models.

CO4: Forecast the travel demand on various links of urban transport network.

CO5: Draw various planning alternatives and suggest the best alternative for implementation.

Module 1: (9 hours)

Urban Transportation Planning Process and Concepts: Role of transportation - Transportation problems - Urban travel characteristics - Evolution of transportation planning process - Concept of travel demand - Demand function - Independent variables – Travel attributes - Assumptions in demand estimation - Sequential, recursive and simultaneous processes

Module 2: (10 hours)

Trip Generation Analysis: Definition of study area - Zoning - Types and sources of data -Road side interviews - Home interview surveys - Expansion factors - Accuracy checks - Trip generation models - Zonal models - Category analysis - Household models - Trip attractions of work centers.

Module 3: (10 hours)

Trip Distribution Analysis: Trip distribution models - Growth factor models – Gravity models - Opportunity models.

Module 4: (10 hours)

Mode Split Analysis: Mode split analysis - Mode choice behaviour, Competing modes, Mode split curves, Probabilistic models.

Route Split Analysis - Route split analysis: Elements of transportation networks, coding -minimum path trees, all-or-nothing assignment.

References:

1. Khisty, C.J., Transportation Engineering – An Introduction, Prentice Hall, 3rd Edition, 2002.
2. Papacostas, Fundamentals of Transportation Planning, Tata McGraw Hill, Third Edition, 2002.
3. Dicky, J.W., Metropolitan Transportation Planning, Tata McGraw Hill, 1983
4. Bruton, M.J., Introduction to Transportation Planning, Hutchinson of London, 1970.
5. Hutchinson, B.G., Principles of Urban Transportation System Planning, McGraw Hill
6. ITE (1982), 'Transportation and Traffic Engineering Hand Book', Chapters 10,12, and 17, Prentice Hall, New Jersey
7. Kanafani, A., Transportation Demand Analysis, McGraw-Hill, 1983.
8. Konstadinos G. Goulias, Transportation Systems Planning: Methods and Applications, CRC Press, 2002
9. Meyer, M.D. and Miller, E.J., Urban Transportation Planning, McGraw-Hill International, 2001
10. Oppenheim, N., Applied Models in Urban and Regional Analysis, Prentice-Hall, NJ, 1995.
11. Ortuzar, J. D.,andWillumsen, L. G., Modelling Transport, John Wiley and Sons Ltd, 2001.
12. Wilson, A.G, Urban and Regional Models in Geography and Planning, John Wiley and Sons, 1974.

CE3037D PAVEMENT ANALYSIS AND DESIGN

Pre-requisites: CE3005D Transportation Engineering I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Identify the pavement types based on their behaviour under traffic

CO2: Analyse the pavement components with respect to their material composition.

CO3: Estimate the stresses induced due to wheel load and temperature.

CO4: Design the pavement, flexible or rigid, for the conditions prevailing at site.

CO5: Provide feedback to update the design guidelines.

Module 1: (10 hours)

Introduction: Types and Component parts of Pavements, Factors affecting Design and Performance of Pavements, Comparison between Highway and Airport pavements, Superpave.

Stresses in Flexible Pavements: Stresses and Deflections in Homogeneous Masses, Burmister's 2-layer, 3- layer Theories, Wheel Load Stresses, ESWL of Multiple Wheels, Repeated Loads and EWL factors, Sustained Loads and Pavement behaviour under Traffic Loads.

Module 2: (10 hours)

Methods of Flexible Pavement Design: Empirical, Semi-empirical and Theoretical Approaches; Development, Principle, Design steps, Advantages and Applications of different Pavement Design Methods – Flexible Overlay Design.

Module 3: (10 hours)

Stresses in Rigid pavements: Causes and Effects of variation in Moisture Content and Temperature, Depth of Frost Penetration - Types of Stresses and Causes, Factors influencing the Stresses; General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses.

Module 4: (9 hours)

Methods of Rigid Pavement Design: Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacings, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design – Continuously Reinforced Concrete Pavement Design - Rigid Overlay Design.

References:

1. Yoder and Witczak, Principles of Pavement Design, John Wiley and sons, Second Edition, 1975.
2. David Croney, The Design and Performance of Road Pavements, McGraw Hill, 1997
3. Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall, 2002.
4. IRC: 37, 'Guidelines for the Design of Flexible Pavements'
5. IRC: 58 'Guidelines for the Design of Rigid Pavements'
6. IRC: 81,'Strengthening of Flexible Road Pavements using Benkelman Beam Deflection Technique'
7. IRC:101, Guidelines for Design of Continuously Reinforced Concrete Pavement with Elastic Joints'
8. Lavin, P. G., Asphalt Pavements, Spon Press, 2003.
9. Mechanistic Empirical Pavement Design Guide, NCHRP, TRB, 2008.
10. RRL, DSIR, Concrete Roads, HMSO, IRC Publications
11. Nai C. Yang, Design of functional pavements, McGraw-Hill, 1973
12. Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003
13. Rajib, B.,Mallick, and Tahar El-Korchi, Pavement Engineering: Principles and Practice, CRC Press, 2008

CE3038D TRAFFIC ENGINEERING

Pre-requisites: Transportation Engineering I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
Students will be able to:
CO1: Develop relationships between fundamental parameters, so as to characterise thetraffic flow.
CO2: Conduct traffic engineering studies, analyse and interpret the data.
CO3: Design traffic engineering facilities such as chanellising islands, roundabouts, busstops etc.
CO4: Suggest and plan traffic management measures for street networks.
CO5: Design traffic control devices such as isolated signals and coordinated signals.
CO6: Suggest scientific solutions for mitigating the impact of traffic on the environment.

Module 1: (10 hours)

Scope of Traffic Engineering and Study of its Elements: Introduction - Objectives and scope of traffic engineering - Components of road traffic: vehicle, driver and road - Road user and vehicle characteristics and their effect on road traffic - Traffic maneuvers - Traffic Stream Characteristics-Relationship between Speed, Flow and Density.

Module 2: (9 hours)

Traffic Engineering Studies and Analyses: Objectives, methods, equipment, data collection, analysis and interpretation (including case studies) of (a) Speed and delay, (b) Origin and destination, (c) Parking, (d) Accident and other studies

Module 3: (10 hours)

Design, Regulation and Management of Traffic Engineering Facilities: Control of traffic movements through time sharing and space sharing concepts - Design of channelising islands, T, Y, skewed, staggered, roundabout, mini-roundabout and other forms of at-grade crossings including provision for safe crossing of pedestrians and cyclists - Grade separated intersections: Warrants and design features - Bus stop location and bus bay design - Road lighting - Regulations on vehicles, drivers and traffic - Planning and design of traffic management measures: one-way streets, reversible lanes and roadways, turn regulation, transit and carpool lanes - Planning and design of pedestrian facilities – Traffic calming.

Module 4: (10 hours)

Traffic Control Devices and Environmental Control: Different methods of signal design -Redesign of existing signals including case studies - Signal coordination - Air and Noise pollution of different transport modes - Visual impacts - Impacts on land development -Technological approaches to improving environment

References:
1. Pignataro, L., Traffic Engineering - Theory and Practice, John Wiley, 1973.
2. Kadiyali, L.R., Traffic and Transport Planning, Khanna Publishers, Sixth Edition, 1997.
3. O’ Flaherty C.A., Highways-Traffic Planning and Engineering, Edward Arnold, 2002.
4. Fred L. Mannering, Scott S. Washburn,and Walter P. Kilareski, Principles of Highway Engineering and Traffic Analysis, Wiley; 2008
5. Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice Hall (1982) Chapters 8, 17, 21, 23 and 24.
6. IRC-SP41, Guidelines for the Design of At-Grade Intersections in Rural and Urban Areas, 1994
7. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
8. Matson, Smith andHurd, Traffic Engineering, McGraw Hill Book Co, 1965
9. Michael, A. P. Taylor, William Young, and Peter W. Bonsall, Understanding Traffic Systems, Ashgate Publishing; 2000.
10. Mike Slinn, Paul Matthews, Peter Guest, Traffic Engineering Design, Second Edition: Principles and Practice, Butterworth-Heinemann, 2005

CE3039D ENVIRONMENTAL LAW AND POLICY

Pre-requisites:CE2010D Environmental Studies or Equivalent Course

Total hours: 39

L	T	P	C
3	0	0	3

Course Outcomes:

Students will be able to:

CO1: Demonstrate knowledge in the environmental redress mechanism available in India.

CO2: Give general advice regarding the legal remedies available in the country in the event of pollution.

CO3: Advice on the legal provisions to be complied by the occupier of various facilities that may cause pollution

CO4: Demonstrate knowledge in international environmental law.

Module 1: (13 hours)

Introduction to Law, Legal Systems and Environmental Law

Introduction to law- Its functions- Categorizing laws and legal systems- The Indian judicial system

Constitution as a source of law: fundamental rights, right to constitutional remedy

Constitutional Provisions for environment protection- Public nuisance provisions against pollution: IPC, CrPC- tort provisions against pollution

Principles of environmental law: Polluter pay, Precautionary, Public Trust, Strict& Absolute Liability

Module 2: (13 hours)

Environmental Policy and Law

Environmental Philosophy and ethics- Social & Civil Society movements to protect environment

National Environmental Policy- Land-use policy& Common Property Resources

Regulations on EIA- Pollution Control regulations: Environment Protection Act, Water Act, Air Act

Waste management regulations: Solid waste, E Waste, C&D Waste, Plastic Waste, Biomedical waste, Hazardous waste

Module 3: (13 hours)

International environmental law

Global environmental governance- Evolution of international environmental law: UN conference on the human environment, UN Conference on environment and development, Rio declaration, Agenda 21, World Commission on environment and development

Global environmental conventions, treaties and protocols: Climate change, Biodiversity, Wetland protection, Ozone layer protection, Protection of marine environment

Environmental provisions in international trade agreements

References:

1. Kamala Sankaran & Ujjwal Kumar Singh, Towards Legal Literacy: An Introduction to Law in India, Noida, India: Oxford University Press, 2007.
2. P. M. Bakshi, The Constitution of India, New Delhi, India: Universal Law Pub. Co., 2015.
3. Pierre-Marie Dupuy & Jorge E. Viñuales, International Environmental Law, Cambridge, England: Cambridge University Press, 2015
4. The Gazette of India (for relevant statutes)

CE3040D AIR POLLUTION CONTROL ENGINEERING

Pre-requisites: CE2010D Environmental Studies

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Demonstrate knowledge on the various priority pollutants in ambient air and their deleterious effects on various components of environment

CO2: Model the dispersion of pollutants from a point source for given weather conditions

CO3: Discuss the various removal methods for primary and secondary pollutants originating from various Industries

CO4: Demonstrate knowledge on the various types of indoor air pollutants and their health impacts

CO5: Advice on the type of air pollution control technique to be adopted for a given case

Module 1: (13 hours)

Definitions- Sources of air pollutants : Point source, Non-point source, Natural and anthropogenic - classifications of pollutants: Based on their source, nature, Stability, Size, Priority –Air quality standards : International and National - Units of measurement- Meteorology and its effects: Pressure, Temperature, Humidity- Transport mechanism of pollutants : Advection ,Diffusion , Dispersion- Atmospheric stability and inversion –Plume behavior – Design of stack height - Effects on environment: human beings, vegetation, animals, materials and climate

Module 2: (13 hours)

Objective of sampling- Averaging principle- Standard sampling methods: Selection of type of sampling, Sampling locations, duration, Frequency of sampling,Isokinetic sampling- Objective and types of modeling – Principle, important consideration and application of fixed box model, Gaussian dispersion model, multiple cell model.

Indoor air pollution- significance, pollutants and their impacts, measurement, control

Module 3: (13 hours)

Air pollution control technology-Objectives, Principles, applications, process, design, performance,limitations and modifications of gravity settler, cyclone separator, Electro-static precipitator(ESP), fabric filter and venturi scrubber for control of particulate matter and Objectives, Principles, applications, process, design, performance ,limitations of absorption, adsorption , combustion and condensation process for control of gaseous pollutants.

References:

1. N.D. Nevers, Air pollution control engineering, New York: McGraw-Hill International Editions, 2000.
2. Arcadio P. Sincero,Gregoria A. Sincero, Environmental Engineering – A Design Approach, New Delhi: PHI Learning, 2009.
3. M. N. Rao and H.V.N. Rao, Air Pollution, Delhi: McGraw-Hill Education, 2001.
4. Peter Pluschke (Ed.), Indoor Air Pollution, New York: Springer, 2004

CE3041D SOLID WASTE MANAGEMENT

Pre-requisites: CE2010D Environmental Studies

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Demonstrate an understanding of sources, characteristics and composition of solid wastes

CO2: Design and implement a waste collection system

CO3: Assess technical options and processes involved in recycling of wastes and plan a recycling programme.

CO4: Determine the most viable waste disposal option of a locality and design landfills.

CO5: Develop an integrated waste management system for a locality involving the public.

Module 1: (13 hours)

Solid Wastes: Types and Sources, Waste Characteristics: physical- chemical, Effects on – Environment- Health, Need of Solid Waste Management

Waste collection, Storage and Transport: Storage containers- collection vehicles, collection system types, collection routes, transfer stations, Waste Collection System design

Module 2: (13 hours)

Waste Processing techniques: Purpose, mechanical size alteration – shredding-compaction, component separation methods – drying and dewatering

Recovery of Biological Conversion Products – Composting- stages – types, Biogasification- metabolic stages- types of digesters

Recovery of Thermal Conversion Products – Incineration - technologies, Pyrolysis, Energy Recovery Systems, Recycling: significance – Recycling programme elements – planning

Module 3: (13 hours)

Ultimate Disposal: Disposal in Landfills - Site Selection - Design and Operation of Sanitary Landfills - Closure of Landfills - Landfill Remediation, Land farming.

Elements of Integrated Waste Management

Solid waste management statutes in India- Solid Waste Management Rules 2016, Construction and Demolition Waste Management Rules*,* 2016

References:

1. George Tchobanoglous and Frank Kreith, Handbook of Solid Waste Management, New York, USA: McGraw-Hill Education, 2002
2. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2016.
3. Department of Publication, Government of India, Gazette of India- for relevant statutes

CE3042D PRESTRESSED CONCRETE DESIGN

Pre-requisites: CE3002D Structural Design I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Analyse prestressed concrete structural members and estimate the losses of prestress

CO2: Analyse and design of prestressed concrete structural elements as per IS 1343

CO3: Design prestressed concrete flexural members, composite members and statically indeterminate structures

Module 1: (13 hours)

Basic principles: Introduction – need for prestressed concrete – structural behaviour of prestressed concrete member – methods of prestressing – pre-tensioning and post-tensioning – anchorage systems – types of prestressed concrete – comparison with reinforced concrete.

Materials: High tensile steel – types of prestressing steel -high strength concrete – properties of high tensile steel and high strength concrete.

Losses in prestress: Immediate losses – time dependent losses – total losses.

Analysis of sections: Analysis at serviceability limit state – combined load approach – internal couple approach – equivalent load approach – concept of load balancing – decompression moment – cracking moment.

Design for flexure: Modes of failure in flexure – ultimate moment of resistance of sections with bonded tendons – strain compatibility method – IS code procedure.

Module 2: (13 hours)

Design for shear and torsion: Effect of prestress in shear strength – zones for shear design – shear resistance of sections – design for shear – failure modes in torsion – design for torsion.

Design of anchorage zones: Anchorage zones in pre-tensioned members – development length – end zone reinforcement – anchorage zones in post-tensioned members – bearing stresses – bursting forces – end zone reinforcement.

Control of deflections: Deflection in type I and type II beams– short term and long term deflections – IS code procedures.

Module 3: (13 hours)

Design of flexural members: Governing stress inequalities for uncracked sections – design of prestressing force – Magnel’s diagram – allowable cable zone – flexural efficiency factor.

Composite members: Analysis at serviceability limit state – stresses due to differential shrinkage – ultimate moment of resistance.

Indeterminate structures: Primary and secondary moments and shears – effective cable line – linear transformation of cable profile – concordant cable – analysis of sections.

References:

1. Lin, T. Y., and Ned H. Burns, Design of Prestressed Concrete Structures, John Wiley and Sons, 2004.
2. Krishna Raju, N., Prestressed concrete, Tata McGraw Hill, 2000.
3. Nagarajan, P.,Prestressed concrete Design, Pearson,2013.
4. Dayaratnam, P., Prestressed Concrete, Oxford and IBH, 1982.
5. Rajagopalan, N., Prestressed Concrete, Narosa publishers, New Delhi, 2004.
6. Relevant BIS codes

CE3043D ADVANCED CONCRETE DESIGN

Pre-requisites: CE3002D Structural Design I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
Students will be able to:

CO1: Familiarize with the provisions in Indian standard codes of practice for the design of concrete roofslabs, water tanks, deep beams, chimneys, shells etc.

CO2: Familiarize with the provisions in IRC codes for the design of RC bridges

CO3: Design simple bridges and understand the behaviour of different types of bridges

Module 1: (13 hours)

Large span concrete roofs: Introduction– classification- behaviour of flat slabs - direct design and equivalent frame method- code provisions - waffle slabs.

Water tanks: Introduction- rectangular and circular with flat bottom- spherical and conical tank roofs-staging- design as per IS code procedures.

Module 2: (13 hours)

Bridges: General – IRC Bridge code –loading standards–impact effect – wind load – longitudinal forces – centrifugal forces – force due to water currents – buoyancy effect – temperature effects – secondary stresses – erection – seismic force Design of slab culvert – R.C box culverts –T-beam bridges – concept on design of continuous bridges, balanced cantilever bridges, arch bridges and rigid frame bridges.

Deep beams: Analysis of deep beams- design as per IS code - design using strut and tie method.

Module 3: (13 hours)

Chimneys: Analysis of stresses in concrete chimneys- uncracked and cracked sections- code provisions- design of chimney.

Shells and Folded plates: Forms of shells and folded plates- structural behaviour of cylindrical shell and folded plate- method of analysis-membrane analysis – beam arch approximation- code provisions- design of simply supported circular cylindrical long shells and folded plates – Shear walls.

References:

1. Varghese, P.C., Advanced Concrete Design – Prentice Hall India Learning Private Limited, 2005.
2. Jain, A.K., Reinforced Concrete –Nem Chand Bros. Roorkee , 1998.
3. Jain and Jaikrishna, Plain and Reinforced Concrete – Vol I and II, NemChand Bros., Roorkee, 2000.
4. Mallick and Gupta, Reinforced Concrete, - Oxford and IBH, 1982.
5. Ramaswamy, G. S., Design and Construction of Concrete Shell Roofs, CBS publishers, 2005.
6. Purushothaman, P., Reinforced Concrete Structural Elements, Tata McGraw Hill, New Delhi, 1986.
7. IRC Codes (IRC 5, IRC 6, IRC 112)
8. Relevant BIS Codes.

CE3044D FINITE ELEMENT ANALYSIS

Pre-requisites: Nil

Total hours: 39

L	T	P	C
3	0	0	3

Course Outcomes:

Students will be able to:

CO1: Formulate a finite element model of a physical system

CO2: Derive element stiffness matrix for a given problem

CO3: Write a computer code and analyse a structure using finite element method

CO4: Use latest commercial FE software packages

Module 1: (14 hours)

Introduction:Basic concepts of FEA, mathematical modeling of physical systems, exact and approximate methods, background of the development of FEA with emphasis on stress analysis context, flexibility and stiffness approaches to framed structures.

Definitions and basic element operations: Node, degrees of freedom (dof), local or element axes, global axes, interelement equilibrium and compatibility, element force vs displacement relations, flexibility formulation, stiffness formulation, mixed force displacement formulation, work and reciprocity, flexibility - stiffness transformations, transformation of stiffness to flexibility, transformation of flexibility to stiffness.

Basic equations of elasticity: Rotations vs displacements at a point, equations of equilibrium, static boundary conditions, strain - displacement relations, stress at a point, generalized Hooke's law - anisotropic form, orthotropic, isotropic, transverse isotropic – two dimensional stress distribution - Hooke's law for plane stress, Hooke's law for plane strain, axisymmetric problem

Module 2: (14 hours)

Transformation of element relations: Element transformation matrices (element global transformations): transformation of dof and transformed stiffness relations - truss element, plane frame element, and space frame element, condensation of dof.

Global analysis procedure: Direct stiffness method - basic concept, direct stiffness method - general procedure.

Finite element formulations: formulation of element force - displacement relations- direct method- examples.

Variational method of element formulation: Principle of stationary potential energy, principle of virtual displacement, F.E discretisation of virtual work, distributed body forces, distributed inertial forces and consistent mass matrix, approximation to geometry.

Method of weighted residuals: Galerkin criteria, examples.

(Examples of element formulation may be limited to axial bar, triangular/rectangular element in plane stress/strain and beam elements)

Module 3: (11 hours)

Representation of element functions for behaviour and geometry: Requirements of element behaviour functions-polynomial series single and two variables-Pascal triangle and tetrahedron - polynomial functions for 2d rectangular elements, direct construction of shape functions through interpolation-natural coordinates- 2 and 3 dimensions- Lagrangian interpolation in natural co-ordinates- Hermitian interpolation- rectangular elements by Lagrangian interpolation- internal nodes and reduction to simpler forms.

Isoparametric formulations: Concept of isoparametric formulation- plane rectangular elements-Jacobian-numerical integration.

References:

1. Gallaghar, R.H., Finite Element Analysis: Fundamentals, Prentice Hall Inc, 1975.
2. Bathe, K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India, 1996.
3. Desai, C.S., Elementary Finite Element Method, Prentice Hall of India, 1979.
4. Cook, R.D., et al, Concepts and Applications of Finite Element Analysis, John Wiley, 2007.
5. Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Prentice Hall of India, 2014.
6. Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheeler Pub, 2008.
7. Zienkiewicz, O.C., and Taylor, R.L., The Finite Element Method, Vol. I and II, McGraw Hill, 2000.
8. Krishnamoorthy, C.S., Finite Element Analysis – Theory and Programming, Tata McGraw Hill, New Delhi, 1995.

CE3045D COMPUATIONAL ELASTICITY

Pre-requisites: CE2001D Mechanics of Solids or equivalent

Total: 39 hours

L	T	P	C
3	0	0	3

Course Outcomes:

Students will be able to:

CO1: Formulate static problems of elasticity both as boundary value problem and variational problem

CO2: Analyse elastostatic problem using the finite element method and interpret results correctly

CO3: Develop simple computer codes for the finite element analysis of elastostatic problems

Module 1: (13 hours)

Introduction to theoretical elasticity: Analysis and design of structural systems-elastostatics- types of loads- displacement-, strain- and stress-fields; two-dimensional idealisations,-plane stress and plane strain problems- differential equations of equilibrium-stress-strain and strain-displacement relations-mathematical statement of the problem- one-dimensional problems of axially loaded bar and beam as examples.

Introduction to computational elasticity: Significance of computational solution- 'exact'and 'approximate' solutions- popular computational methods- introduction to finite element method-brief history.

Module 2: (13 hours)

Interpolation: Shape functions for C^0 and C^1 elements -Lagrangian and Hermitian interpolation functions for one dimensional elements-Lagrangian interpolation functions for two-dimensional elements.

Variational formulation: Potential energy of an elastic body - Rayleigh-Ritz method- piecewise polynomial field- finite element form of Rayleigh-Ritz method- finite element formulation derived from functional.

Displacement-based elements for structural mechanics: Formulas for element stiffness matrix and load vector- overview of element stiffness matrices- consistent element nodal load vector - equilibrium and compatibility in the solution - convergence requirements - patch test- optimal stress points.

Module 3: (13 hours)

Structure stiffness equations: Properties of [*K*], solution of unknowns- element stiffness equations - assembly of elements - displacement boundary conditions - Gauss elimination solution of equations - stress computation - support reactions - summary of finite element procedure.

The isoparametric formulation: Plane bilinear element- Gauss quadrature- quadratic plane elements-transition elements - consistent element nodal loads - appropriate order of quadrature - stress computation.

Coordinate transformation: Transformation of vectors, transformation of stress- strain - material properties- and stiffness. Topics in structural mechanics: Condensation – substructuring - symmetry.

References:

1. Cook, R.D., et al,Concepts and Applications of Finite Element Analysis, John Wiley, India, 2001.
2. Krishnamoorthy, C.S., Finite Element Analysis, Theory and Programming, Tata McGraw Hill, India, 1996.

3. Zienkiewicz, O.C., Taylor, R.L., and Zhu, J.Z., The Finite Element Method—Its Basis & Fundamentals, 6th Edition, Elsevier, India, 2007.
4. Timoshenko, S.P. and Goodier, J.N., Theory of Elasticity, McGraw Hill, Singapore, 1982.
5. Ameen, M., Computational Elasticity—Theory of Elasticity, Finite and Boundary Element Methods, Narosa Publishing House, India, 2008.
6. Desai, C.S., Elementary Finite Element Method, Prentice Hall of India, 1998.
7. Rajasekaran, S., Finite Element Analysis in Engineering Design, Wheeler Pub, India, 1998.
8. Shames, I.H., and Dym, C.L., Energy and Finite Element Methods in Structural Mechanics, Wiley

CE3046D ADVANCED SURVEYING

Pre-requisites: CE2004D Surveying

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Carryout regional level surveys for preparation of topographical maps at various scales.

CO2: Adopt statistical techniques to estimate the most probable values of the measured quantity.

CO3: Analyze and synthesize data from the aerial photographs and remote sensing images to prepare thematic maps.

Module 1: (12 hours)

Triangulation and Trilateration

Triangulation – Principle – Classification of triangulation system–Triangulation figures and layouts- Well conditioned triangle – Strength of figure – Signals and towers – Baseline measurement and extension –Intervisibility of stations – Phase of signal – Satellite station and reduction to centre – Eccentricity of the signal – Location of points by intersection and resection – Trilateration – Reduction of slope distances

Module 2: (12 hours)

Theory of Errors

Survey adjustments and theory of errors – Introduction – Laws of accidental errors – Probability curve – Principle of least squares – Laws of weights – Probable error – Normal equation – Most probable value – Method of correlates – Angle adjustment – Station adjustment – Figure adjustment – Adjustment of triangles – Adjustment of a quadrilaterals

Module 3: (15 hours)

Aerial Photogrammetry and Remote Sensing

Aerial Photogrammetry – Basic concepts – Geometry of vertical photographs – Scale and Flying height – Relief displacement - Flight planning computations – Stereoscopy and Parallax – Photo mosaic – Elements of photo interpretation.

Concepts and foundations of remote sensing- Energy sources and radiation principles- Energy interactions in the atmosphere – Energy interaction with earth surface features - Spectral reflectance of vegetation, soil and water - Atmospheric influence on spectral response patterns - Characteristics of Remote sensing satellites and sensors (IRS, Landsat, SPOT, IKONOS)

References:

1. Chandra A.M., Higher Surveying, New Age International Private Limited, 2015
2. James Anderson and Edward Mikhail, Surveying: Theory and Practice, McGraw Hill Education; 7th edition, 2017
3. Thomas. M. Lillesand, Ralph. W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation , John Wiley and Sons, Inc., Sixth Edition, 2011
4. George Joseph, Fundamentals of Remote Sensing, Universities Press, Second edition, 2005
5. Manoj K. Arora and R.C. Badjatia, Geomatics Engineering, Nem Chand publishers, First edition, 2011

CE4021D ADVANCED GEOTECHNICAL ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Familiarize with foundation design taking into consideration soil structure interactions
CO2: Do designs of sheet piles
CO3: Learn design of foundations and vibration isolation techniques
CO4: Familiarize with various modern foundation designs like shell and folded plate foundations

Module 1: (13 hours)

Soil structure interaction problems: introduction with practical examples,Soil models, single parameter model (Winkler), Two parameter models (Filonenko-Borodich model, Pasternaak model, Hetengi model) – Visco – elastic model, Elastic continuum model. (only outline of salient features and discussion of limitations of the models is expected) – Contact pressure distribution beneath a rigid footing- concentrically and eccentrically loaded cases. Contact pressure distribution beneath flexible footings. Contact pressure distribution below rafts – Parameters affecting contact pressure distribution Method of analysis of contact pressure distribution – Modulus of sub grade reaction approach (Winkler model) – Classical solution of beams on elastic foundation – Solution for beam of infinite length subjected to central concentrated load and central moment – Beams of finite length – Formulation of basic equations for slabs resting on elastic foundation – Application to design of combined footings

Module 2: (15 hours)

Sheet pile walls and cofferdams: Types and uses of sheet piles – Design of cantilever and anchored sheet pile walls -Anchors – Types and uses of coffer dams – Single wall coffer dams – Soil pressure on single walled (braced cofferdams) – Design of single wall cofferdams-Cellular stability of cellular cofferdams-Instability due to heave of bottom of excavation-Condition for piping- Conditions for blow in

Machine foundations: Basic theory of vibration – Free and forced vibration of single degree of freedom with and without damping – Two degrees of freedom with and without damping – Dynamic soil properties – Mass spring model and constants – Elastic half space approach – Determination of dynamic soil constants in laboratory and field based on I.S code provisions. Modes of vibration of block foundation Natural frequency of foundation soil system by Barkan's approach – Method of analysis – Barkan's method – Verticals- Translation, sliding, rocking and yawing (I.S code method)

Module 3: (11 hours)

Special foundation : Shell foundations – Structural form and efficiency – Different types of shell foundations – General principles of design of shell foundations – Special features of the foundations for water tanks, silos, chimneys and transmission line towers - Foundations for offshore structures – Gravity structures – Jack up type structures – Design considerations

References:

1. Shamsher Prakash, Soil Dynamics, McGraw Hill, 1981.
2. Alexander Major, Dynamics in soil Engineering, Acamemiai, 1980.
3. Bowles, J. E., Foundation analysis and design, McGraw Hill, 1996
4. Das, B. M ,Principles of soil Dynamics, Brooks/Cole, 2010.
5. Krammer, S. L, Geotechnical earthquake engineering, Prentice – Hall, 1996

CE4022D SOIL DYNAMICS AND DESIGN OF MACHINE FOUNDATIONS

Pre-requisites: CE3004D Geotechnical Engineering II

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Familiarize with various theories of machine foundation design
CO2: Do designs of foundations subjected to vibrations
CO3: Learning to evaluate dynamic soil properties
CO4: Familiarize with vibration isolation techniques

Module 1: (12 hours)

Introduction - nature of dynamic loads - stress conditions on soil elements under earthquake loading - dynamic loads imposed by simple crank mechanism - type of machine foundations - special considerations for design of machine foundations - theory of vibration: general definitions - properties of harmonic motion - free vibrations of a mass-spring system - free vibrations with viscous damping - forced vibrations with viscous damping - frequency dependent exciting force - systems under transient forces - Raleigh's method - logarithmic decrement - determination of viscous damping - principle of vibration measuring instruments - systems with two degrees of freedom - special response

Module 2: (15 hours)

Criteria for a satisfactory machine foundation - permissible amplitude of vibration for different type of machines - methods of analysis of machine foundations - methods based on linear elastic weightless springs - methods based on linear theory of elasticity (elastic half space theory) - methods based on semi graphical approach - degrees of freedom of a block foundation - definition of soil spring constants - nature of damping - geometric and internal damping - determination of soil constants - methods of determination of soil constants in laboratory and field based on IS code provisions- Vertical, sliding, rocking and yawing vibrations of a block foundation - simultaneous rocking, sliding and vertical vibrations of a block foundation - foundation of reciprocating machines - design criteria - calculation of induced forces and moments - multi-cylinder engines - numerical example (IS code method)

Module 3: (12 hours)

Foundations subjected to impact loads - design criteria - analysis of vertical vibrations - computation of dynamic forces - design of hammer foundations (IS code method) - vibration isolation - active and passive isolation - transmissibility - methods of isolation in machine foundations

References:

1. Shamsher Prakash, Soil Dynamics, McGraw-Hill, 1981.
2. Alexander Major, Dynamics in Soil Engineering, Akademiai,1980.
3. Sreenivasalu and Varadarajan, Handbook of Machine Foundations, Tata McGraw-Hill, 2007.
4. IS 2974 - Part I and II, Design Considerations for Machine Foundations
5. IS 5249: Method of Test for Determination of Dynamic Properties of Soils

CE4023D EARTH AND ROCKFILL DAM ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Familiarize with various construction techniques of earth dams

CO2: Do designs of earth and rock fill dams

CO3: Learn to evaluate shear strength and seepage forces

CO4: Familiarize with various laboratory and filed tests for seepage analysis

Module 1: (11 hours)

Introduction: use of earth and rockfill dams - general features of earth and rockfill dams - types of earth dams - materials available for embankment construction - character of foundation - climate - shape and size of valley - river diversion - probable wave action-time available for construction - function of reservoir -earthquake activity - study of typical embankment sections including earth dams on Kerala. **Exploration for foundation and embankment construction materials**: influence of topography and sub-soil conditions on site selection - foundation subsurface exploration - studies of embankment construction materials.

Module 2: (16 hours)

Earth dam design: Basic consideration in design - location and alignment of dam - design of foundation - embankment design - design of internal drainage system - embankment details - design of appurtenances - design of provisions to control pore pressure - earth dams on pervious foundations - methods of foundation treatment - prevention of under seepage with complete vertical barrier - reducing under seepage - controlling under seepage - special design problems - measuring instruments and performance observations - design considerations on earthquake regions - loose sand foundation - foundations of soft clay and silt - upstream slope wave protection - downstream slope protection

Construction of earth dams: phases of construction - site preparation - river diversion and cofferdam construction - foundation preparation - borrow pit excavation - fill placement - soil compaction - construction control - slope treatment and riprap Measurement of movements and pore water **pressures**: embankment movements during construction - post construction embankment movement - pore water pressures during construction - pore pressure measuring equipment Rockfill dams: general features - materials - design of rockfill dams and components - facing with different materials - spillways and free board - core wall type - earth core type - construction of rockfill dams Hydraulic fill dams: general features - analysis of hydraulic fill dams - construction details

Module 3: (12 hours)

Advanced theory of seepage and shear strength: seepage pressure - quick conditions - laplace equation - flownet phreatic line on earth dam - a Casagrande‘s solution - Shaffernak and Van Iterson solution - Leo Casagrande solution - piping and exit gradient - Khosla‘s theory - composite profile - Schwarz Christoffel transformation - determination of permeability in soil-rock - longitudinal test - radial test - shear tests on rock - single jack test - direct shear test on rock cubes -punch shear test - shear box tests - tensile strength tests on rock - brazilian test - flexural strength for bending test - young‘s modulus by bending test and brazilian tests **Stability analysis**: Standard methods of analysis - Taylor‘s modified swedish method including side forces between slices - wedge method (sliding block) - stability conditions during construction - full reservoir and draw down conditions - pore pressure due to gravity seepage after instantaneous draw downs

References:

1. Bharath Singh and Sharma, Earth and Rockfill dams, Saritha Prakashan, Meerut,1976
2. Sowers, G. F., Earth and Rockfill Dam Engineering, Asia Publishing, 1962.
3. Sherad et al., Earth and Earth Rock Dams- Engineering Problems of Design and Construction, John Wiley, 1967.
4. Thomas, H. H., Engineering of Large Dams-Part II, 1976.
5. Verma, B. P., Rock Mechanics for Engineers, Khanna Publishers, 1989.

CE4024D NUMERICAL MODELLING IN GEOTECHNICAL ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Familiarize with soil modelling techniques
CO2: Apply critical state soil mechanics for geotechnical analysis
CO3: Learn various finite element based software‘s to solve geotechnical problems
CO4: To familiarize with elastic and plastic models

Module 1: (12 hours)

Modelling of Soil Behaviour: Critical state theory; stress paths within and on the state boundary surface; shear strength of clays related to the critical state concept. **Basic Concept of Continuum Mechanics:** Notations; stresses and strains in three dimensions; equations of equilibrium, geometric conditions and constitutive relations

Module 2: (15 hours)

Material modeling: Elastic models; perfect plasticity models-Coulomb model-Drucker-prager model; Hardening plasticity models; generalized stress-strain relations and stiffness formulations; cap model in isotropic consolidation test and triaxial shear test; simulation of pore pressure; case studies on implementing the models**; Finite element modeling:** Introduction to numerical methods - FEM, FDM, BEM; FEM for 1D and 2D problems; FEM for non-linear problems

Module 3: (12 hours)

Application of Finite element modeling: Effective stress analysis, seepage and consolidation problems; practical aspects related to foundations, embankments and retaining structures; application examples-use of ABAQUS, PLAXIS, MIDAS_GTS programs etc.

References:

1. Chen, W. F. and Mizuno, E., Nonlinear analysis in Soil Mechanics: theory and Implementation, Elsevier science publishers, 1990
2. Fethi Azizi, Applied Analyses in Geotechnics, EandFN Spon of Taylor and Francis group, 2000
3. Desai, C. S., Elementary Finite Element Method, Prentice-Hall, 1979.
4. Owen, D. R. J., Hinton, E, Finite Element in Plasticity: Theory and Practice, Pineridge Press Limited, 1980
5. Helwany, S, Applied Soil Mechanics with ABAQUS Applications, John Wiley and Sons, 2007.
6. Lewis, R. W.,Schrefler, B. A., The Finite Element Method in the Deformation and Consolidation of Porous Media, John Wiley and Sons, 1984
7. Zienkiewicz, O. C., Chan, A. H. C., Paster, M., Schrefler, B. A., Shiomi, T., Computational Geomechanics with special reference to earthquake engineering, John Wiley and Sons, 1999.

CE4025D ENVIRONMENTAL HYDRAULICS

Pre-requisites: CE2002D Mechanics of Fluids & CE4003D Environmental Engineering II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Understand the basics of how hydrodynamics influences transport

CO2: Learn about applications of hydraulics in treatment plant design

CO3: Compute pollutant concentrations in streams

CO4: Compute pollutant concentrations in lakes/ reservoirs, and estuaries

CO5: Perform DO modeling in streams

Module 1: (14 hours)

Fundamental relationships for flow and transport - general principles, instantaneous equation for fluid flow and transport, Reynold's time-averaged mean flow and transport equations, model resolution, solution techniques, data requirements.Measurement and analysis of flow - measurement of velocity and flow, tracer studies, estimating design flows.Hydraulic analysis for grit chamber and upstream components, primary clarifier, aeration basin, final clarifier and chlorine contact basin in a typical water treatment plant.

Module 2: (13 hours)

Models for rivers and streams - completely mixed systems - reaction kinetics, mass balance and steady state solution, particular solutions, feed-forward systems of reactors, feed-back systems of reactors, computer methods.BOD and dissolved oxygen (DO) saturation, Streeter-Phelps equation, point and distributed sources.Incompletely mixed systems - diffusion, distributed systems – steady and unsteady cases, steady state solutions, simple time variable solutions.

Module 3: (12 hours)

Rivers and streams- stream hydro-geometry, low- flow analysis, dispersion and mixing, flow model complexity and data requirements, estimating mixing in streams and rivers, hydraulic methods for steady and unsteady flows and solution techniques, routing and water quality problems.Mixing in lakes and reservoirs and water balance.Transport and mixing in estuaries

References:

1. Steven. C. Chapra, Surface Water Quality Modeling, Waveland Press Inc., 2008.
2. James. L. Martin, and Steven. C. Mc Cutcheon, Hydrodynamics and Transport for water Quality Modeling, CRC Press, 1999.
3. Larry D. Benfield, Joseph. F. Judkins, and A. David Parr, Treatment Plant Hydraulics for Environmental Engineers, Longman Higher Education, 1984.
4. Larry. W. Mays (ed.), Hydraulic Design Handbook, Mc Graw Hill Inc., 1999.
5. Vijay. P. Singh, and Willi. H. Hager (eds.), Environmental Hydraulics, Springer, 2016.
6. Willi. H. Hager, Wastewater Hydraulics, Springer Verlag, 2010.
7. John. W. Nicklow, Comprehensive Water and Wastewater Treatment Plant Hydraulics Handbook for Engineers and Operators, MWH Soft, Inc., 2005.
8. Frank. R. Spellman, Handbook of Water and Wastewater Treatment Plant Operations, CRC Press, 2014.

CE4026D ENVIRONMENTAL IMPACT ASSESSMENT OF CIVIL ENGINEERING PROJECTS

Pre-requisites: CE2010D Environmental Studies or Equivalent Course

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Demonstrate knowledge in environmental impact analysis (EIA) and its current status, regulations, and practice in India.

CO2: Demonstrate knowledge in the techniques and tools for assessing and predicting environmental impacts, and will be able to discuss the formulation, roles and limitations of these techniques.

CO3: Carry out an EIA and interpret the results for decision making given some guidance

CO4: Critique impact assessments and discuss methods for mitigating adverse impacts.

CO5: Communicate the key aspects of environmental impact assessment with the stakeholders in the EIA process.

Module 1: (10 hours)

Concept of environment, Concept of environmental impact, Environmental impact assessment (EIA) – definitions, terminology and overview, the role of EIA in relation to the planning and decision-making process, Evolution of EIA. Evolution of EIA in India, Environmental legislations in India, EIA notifications, Major features of the EIA notification in India, Present status and procedures of EIA in India.

Module 2: (16 hours)

Environmental baseline, Impact assessment methods – checklists – matrices - quantitative methods – networks - overlay mapping. Category of projects, Introduction to Impact Prediction, Evaluation and Mitigation- air, noise and water environment, assessment of socio-economic impacts, assessment of ecological impacts, Evaluation of alternatives, Preparing the EIA document, Environmental impact statement (EIS). Techniques for conflict management and dispute resolution, EIA case studies for selected projects.

Module 3: (13 hours)

Environmental audit- Definitions and concepts, partial audit, compliance audit, methodologies and regulations, Contents of EA reports, Introduction to ISO and ISO 14000, case studies in ISO 14000, environmental management techniques, Environmental Monitoring Plan.

Concept of sustainable development, CDM initiatives in India, Life cycle assessment, procedures for LCA, Stages in LCA of a Product. Triple bottom line concept, design for environment, Energy, water, carbon and ecological footprints.

References:

1. Larry W Canter, Environmental Impact Assessment, McGraw Hill, Inc, 1995.
2. Betty Bowers Marriot, Environmental Impact Assessment: A Practical Guide, McGraw Hill, Inc, 1997.
3. Barrow, C. J., Environmental and Social Impact Assessment – An Introduction, Edward Arnold, 1997.
4. Peter Morris (ed.) and Riki Therivel (ed.), Methods of Environmental Impact Assessment, Routledge, 2001.
5. UNEP, Environmental Impact Assessment Training Resource Manual, 2002.
6. Website of the Ministry of Environment and Forests, Govt. of India and the USEPA.

CE4027D HYDROPOWER

Pre-requisites: CE2002D Mechanics of Fluids

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Understand the basics of hydropower generation
CO2: Plan a hydroelectric project
CO3: Design major components of a hydroelectric project
CO4: Perform dam break analysis
CO5: Understand the economics of hydropower generation

Module 1 (13 hours)

Sources of energy - Hydropower – Place of hydropower in a power system – Fundamentals of Water Power Engineering- Classification of hydropower plants. Water power estimates – Essentials of stream flow for water power studies. Pondage and storage – effect of pondage on plant capacity. Benefits from storage. Basic Hydrology. Mass curve and flow duration curve. Effect of reservoirs on flood flow. Load curve and load factor. Utilisation factor. Capacity factor. Diversity factor. Firm Power and Secondary Power. Prediction of load.

Module 2 (14 hours)

Run of the river plants. Pumped storage plants. General arrangement of power house. Types of power house. Mini and micro hydel plants. Tidal Power Plants. Intakes. Forebay. Gates. Penstocks, Canals and Tunnels. Joints. Anchor Blocks. Bends and Manifolds. Valves. Water Hammer. Surges and Surge Tanks.

Module 3 (12 hours)

Turbines and Generators. Flood routing through reservoirs and channels. Dam breach analysis. Cost and value of water power.

References

1. W. P. Creager and J. D. Justin, *Hydroelectric Handbook*, John Wiley and Sons, 1963.
2. Barrows, H.K., *Water Power Engineering*, Mc Graw Hill Inc, 1955.
3. E. Mosonyi, *Water Power Development*, Hungarian Academy of Sciences, 1965.
4. Guthrie Brown, *Hydroelectric Engineering Practice*, Blackie and Sons Ltd; London, 1984.
5. M. M. Dandekar and K. N. Sharma, *Water Power Engineering*, Vikas Publishing House (P) Ltd., 2015.
6. P. S. Nigam, *Handbook of Hydro Engineering,* Nem Chand and Sons, Roorkee, 1985.
7. John S. Gulliver, and Roger E. A. Arndt, *Hydroelectric Engineering Handbook*, Mc Graw Hill Inc., 1991
8. Zheng Naiboet. al., *Mini Hydropower*, John Wiley and Sons, 1997.
9. UNIDO, *Small Hydropower Series*, UN, 1985.
10. Smail Khennas and Andrew Barnett, *Best Practices for Sustainable Development of Mini Hydropower in Developing Countries*, World Bank/ESMAP.
11. Bryan Leyland, *Small Hydroelectric Engineering Practice*, CRC Press, 2014.
12. *Journals and Publications of the CBIP*
13. *Journal of Water Power and Dam Construction.*
14. *Indian Journal of Power and River Valley Development.*
15. Websites - Ministry of Power and the Ministry of Water Resources and Ganga Rejuvenation.

CE4028D URBAN HYDROLOGY AND DRAINAGE

Pre-requisites: CE2006D Open Channel Hydraulics and Hydrology

L	T	P	C
3	0	0	3

Total hours: 39
Course Outcomes:

Students will be able to:

CO1: Perform rainfall and runoff computations for urban catchments.

CO2: Compute overland flow and channel flows.

CO3: Design storm water drainage structures.

Module 1: (13 hours)

Rainfall and Runoff Computations

Introduction - Urbanization –Storm water runoff quantity and quality issues – Rainfall design for urban catchments – Hydrologic and probabilistic description of rainfall – Design rainfall – Methods for construction of design storm hyetographs – Rainfall excess calculations – Computation of abstractions –Combined loss models

Calculation of runoff rates-basic concepts – elements of urban runoff hydrographs – Time of Concentration –Definition and calculation by various methods – Unit hydrograph method – NRCS method (TR-55)

Module 2: (13 hours)

Channel flow and Overland flow

Open-channel flow – Definitions - States of open channel flows – Open - Channel flow equations – Steady Gradually varied flow – Normal flow – Open channel rating curve – Overland flow – Kinematic wave model – Overland flow on impervious and pervious surfaces – Channel flow routing– simplified and numerical models

Module 3: (13 hours)

Storm Water Drainage Structures

Design of storm water drainage structures –Drainage design for street pavements – Storm sewer systems – Culverts – Surface drainage channels

Urban flooding and associated issues – Detention basins – Stage-discharge relationship - Detention basin design - Infiltration structures- Infiltration basins, Trenches

Strom water quality control - Concepts of BMPs and LID – Advantages – Computer models – EPA – SWMM

References:

1. Osman Akan, A and Robert J. Houghtalen, Urban Hydrology, Hydraulics, and Stormwater Quality: Engineering Applications and Computer Modeling, John Wiley and Sons, First edition, 2003
2. Ven T Chow, David Maidment, and Larry Mays, Applied hydrology, Tata McGraw Hill, First edition, 2011
3. Subramanya K., Flow in Open Channels, McGraw Hill Education; 4th edition, 2015
4. Hanif Chaudhry M., Open-Channel Flow, Springer, 2nd edition, 2008
5. National Engineering Handbook, Part 630, Natural Resources Conservation Service, United States Department of Agriculture
6. Storm Water Management Model Applications Manual, USEPA - EPA/600/R-09/077, July 2009

CE4029D DISASTER MANAGEMENT

Pre-requisites: NIL

Total hours: 39

L	T	P	C
3	0	0	3

Course Outcomes:

Students will be able to:

CO1: Understand the basic principles of disaster management

CO2: Understand different types of disasters and issues associated with each of these

CO3: Learn about the national initiatives and framework related to disaster management

CO4: Understand the role of ICT and geoinformatics in disaster management

CO5: Learn about disaster mitigation strategies

Module 1: (14 hours)

Disaster, Hazard, Vulnerability, Resilience, Risks. Natural disasters - hydro-meteorological disasters such as flood, flash flood, cloud burst, drought, cyclone, forest fires etc; geological disasters like earthquake, tsunami, landslides, volcanic eruption. Man made disasters - chemical industrial hazards, major power break downs, traffic accidents, fire hazards, biological hazards, nuclear accidents. Environmental hazards - forest hazards (deforestation, degradation and forest fire), land and soil degradation, desertification and pollution (water, air and soil).Disasters and national losses.Historical perspective of disasters in India and the Indian sub continent.Recent major disasters.Disaster management cycle and its components. Earthquake, Landslide, Flood, Drought, Fire etc - classification, causes, impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts - in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Global warming and climate change. Adaptation.Dos and don’ts during various types of disasters.

Module 2: (13 hours)

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, structural and nonstructural measures, roles and responsibilities of the community, Panchayati Raj institutions/ Urban Local Bodies, States, Centre, and other stakeholders including NGOs. Institutional processes and framework at State and Central Level – National and State Disaster Management Authorities.Prediction and early warning systems.Role of information, education, communication, and training, geoinformatics and IT in disaster preparedness, risk assessment, response, recovery, and management.Role of engineers on disaster management.

Module 3: (13 hours)

Components of disaster relief - water, food, sanitation, shelter, health, waste management, Institutional arrangements for mitigation, response and preparedness, Legislation in India on Disaster Management. National disaster management policy. Other related policies, plans, programmes and legislation relevant to/ pertaining to disaster management. Disaster damage assessment.Disaster mitigation.Existing organization structure for managing disasters in India.Case studies.

References :

1. S. R. Sharma, Disaster Management, A P H Publishers, 2011.
2. Sreeja. S. Nair, Training Manual on Geoinformatics Applications in Disaster Management, NIDM, 2012.
3. Harsh. K. Gupta, Disaster Management, Universities Press, 2003.
4. J. P. Singhal, Disaster Management, Laxmi Publications, 2010.
5. K. Venugopala Rao, Geoinformatics for Disaster Management, Manglam Publishers and Distributors, 2010.
6. Matthews, J.A., Natural Hazards and Environmental Change, Bill McGuire, Ian Mason, 2002.
7. Sulphey, M. M.,Disaster Management, PHI Learning, 2016.
8. Damon P. Coppola, Introduction to International Disaster Management, Butterworth-Heinemann, 2016.
9. Parag Diwan,A Manual on Disaster Management, Pentagon Press, 2010
10. Websites – National Disaster Management Authority, National Institute for Disaster Management, and State Disaster Management Authorities

CE4030D HYDROCLIMATOLOGY

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

The students will be able to:
CO1: Select climate variables affecting precipitation at a location.
CO2: Perform risk assessment and mapping with respect to extreme events.
CO3: Extract GCM projections and downscale these for a river basin.
CO4: Perform hydrological impact assessment of projected climate change.

Module 1: (10 hours)

Introduction to hydro-climatology: climate system; climate, weather and climate; overview of earth's atmosphere; vertical structure of atmosphere; radiation and temperature; laws of radiation; heat-balance of earth atmosphere system; random temperature variation; modeling vertical variation in air temperature; temporal variation of air temperature; temperature change in soil; thermal time and temperature extremes.

Module 2: (10 hours)
Hydrologic cycle: introduction; global water balance; cycling of water on land, a simple water balance model; climate variables affecting precipitation, precipitation and weather, humidity, vapor pressure, forms of precipitation, types of precipitation; cloud; atmospheric stability; monsoon; wind pattern in India; global wind circulation; Indian summer monsoon rainfall.

Module 3: (9 hours)

Climate variability: floods, droughts, drought indicators, heat waves, climate extremes. steps of risk characterization - hazard identification, exposure assessment, vulnerability analysis, risk mapping, risk characterization to natural hazards, risk assessment as a distributed process.

Module 4: (10 hours)

Climate change: introduction; causes of climate change; modeling of climate change, global climate models, general circulation models, downscaling; IPCC scenarios; commonly used statistical methods in hydro-climatology: trend analysis; empirical orthogonal functions, principal component analysis; canonical correlation; statistical downscaling with regression.

References:

1. G. S. Campbell, and J. M. Norman, An Introduction to Environmental Biophysics, Springer, 2000.
2. W. M. Washington, and C. L. Parkinson, An Introduction to Three Dimensional Climate Modeling, Oxford University Press, 2005.
3. M. L. Shelton, Hydroclimatology: Perspectives and Applications, Cambridge University Press, 2009.
4. K. McGuffie, and A. Henderson-Sellers, The Climate Modelling Primer 4th edition, Wiley Blackwell, 2014.
5. IPCC, Fourth and Fifth Assessment Reports, 2016.

CE4031D WATER QUALITY MODELING AND MANAGEMENT

Pre-requisites: CE2006D Open Channel Hydraulics and Hydrology & CE3009D Environmental Engineering - I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Gain knowledge about the basic transport phenomena

CO2: Study different modeling approaches for analyzing water quality problems in rivers, lakes, estuaries, wetlands, groundwater and pipe network

CO3: Apply the models to solve engineering problems and suggest remedial measures

Module 1: (9 hours)

Water quality, standards, Types of contaminants, contaminants and their harmful effects, fate of contaminants, transformation of contaminants, transport of contaminants, Advection, diffusion, dispersion, simple transport models, chemical reaction kinetics, law of mass action, rate constants, types of reactions, equilibrium principles, Introduction to modeling, brief review of mass, momentum and energy balance, governing equations for contaminant fate and transport, Models for Nitrogen, Bacteria, phosphate and toxicants.

Module 2: (9 hours)

Contaminant transport in surface flows, rivers, hydrodynamic processes in rivers, eutrophication, dissolved oxygen in rivers, Streeter-Phelps equation, modification to Streeter-Phelps Equation, models for lakes and reservoirs, biological zones in lakes, eutrophication in lakes, hydrodynamic processes in lakes and reservoirs, stratification, models for estuaries, tidal processes, hydrodynamics of estuaries, stratification of estuaries, eutrophication in estuaries, models for wetlands, characteristics of wetland, hydrodynamics of wetlands, constructed wetlands,

Module 3: (11 hours)

Transport through saturated porous media, groundwater transport phenomena, Groundwater bio reaction and bio kinetics, hydrodynamic dispersion, initial and boundary conditions, unsaturated porous media, capillarity and retention curves, motion equations, initial and boundary conditions fractured media, multiphase flow, flow behavior in pipe networks, quality attenuation, physical characteristics, chemical and biological reactions

Module 4: (10 hours)

Modeling and Management, different types of models, different numerical methods, finite difference method, solution of system of linear equations, Pipe network modeling (EPANET2), surface water quality modeling (QUAL2K),Groundwater modeling (MODFLOW and MT3D), unsaturated zone modeling (SUTRA/HYDRUS), fractured rock water quality management, application of optimization techniques to water quality management, case studies.

References:

1. S. Chapra, Surface Water-Quality Modeling. Long Grove, Ill.: Waveland Press, 2008.
2. L. Rossman, EPANET Users Manual. Cincinnati, Ohio: U.S. Environmental Protection Agency, Center for Environmental Research Information, 1994.
3. J. Martin, S. McCutcheon and R. Schottman, Hydrodynamics and Transport For Water Quality Modeling. Boca Raton, FL: CRC Press, 1999.

4. C.Zheng, and G.D. Bennett. Applied Contaminant Transport Modeling, 2nd ed. New York: John Wiley & Sons, 2002.
5. R. Boulding, Practical Handbook Of Soil, Vadose Zone, And Ground-Water Contamination. Boca Raton: Lewis Publishers, 2004.
6. S.C. Chapra, Pelletier, G.J. and Tao, H., QUAL2K: A Modeling Framework for Simulating River and Stream Water Quality, Version 2.11. USA: Documentation and User's Manual. Civil and Environmental Engineering Department, Tufts University, Medford, 2008.
7. A.W.Harbaugh, E.R Banta, M.C. Hill, and M.G McDonald**,** MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide To Modularization Concepts And The Ground Water Flow Process. U.S. Geological Survey Open-File Report 00-92, 121, 2000.
8. C.Zheng, Chunmiao, and P.P. Wang, MT3DMS — A modular three-dimensional multispecies transport model for simulation of advection, dispersion and chemical reactions of contaminants in ground-water systems. Documentation and user's guide: Jacksonville, Fla., U.S. Army Corps of Engineers Contract Report SERDP-99-1, 1999.

CE4032D OPTIMIZATION OF ENGINEERING SYSTEMS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 39

Course Outcomes:

Students will be able to:

CO1: Formulate engineering design problem as an optimization problem.

CO2: Apply suitable optimization technique to the design problem at hand.

CO3: Use some of the commercial software packages for optimum design.

CO4: Develop and implement problem specific algorithms for optimization.

Module 1: (13 hours)

Introduction to optimization methods, optimization problem formulation, objective function, constraints, Classification of optimization problems.Geometric, graphical, analytical methods of optimization.Application examples from engineering.

Linear programming, simplex method, dual problem, weak duality theorem, optimality criterion theorem, main duality theorem, complementary slackness theorem, primal-dual relationship, economic interpretation of dual solution, introduction to sensitivity analysis, examples of applications of linear programming in engineering.

Module 2: (13 hours)

Dynamic programming, mathematical descriptions of state, stage, and transition.Bellman's principle, forward and backward recursions, discrete and continuous state dynamic programming.

Nonlinear programming, unconstrained and constrained optimization, single variable optimization with and without constraints, multi-variable optimization with and without constraints, method of Lagrange multipliers, Kuhn-Tucker conditions, transformation methods, penalty functions and barrier functions, Gradient projection method.

Module 3: (13 hours)

Integer programming, branch and bound algorithm. Goal programming.Multiobjective programming, Pareto optimal solution, weighting method and constraint method, fuzzy multiobjective optimization method.Examples of applications in engineering.

References:

1. S. S. Rao, Engineering Optimization, New Age International (P) Ltd. Publishers.
2. J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company.
3. Ravindran, D. T. Phillips, J. J. Solberg, Operations Research – Principles and Practice, John Wiley and Sons.
4. K. Deb, Multiobjective Optimization using Evolutionary Algorithms, John Wiley and Sons.
5. Ravindran, K. M. Ragsdell, G. V. Reklaitis, Engineering Optimization – Methods and Applications, John Wiley and Sons.
6. M. S. Bazaraa, H. D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms, Wiley-Interscience.

CE4033D PAVEMENT EVALUATION AND MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Identify the root cause of different pavement distresses.

CO2: Suggest suitable remedial measures for various distresses to improve the pavement surface condition.

CO3: Interpret the field evaluation data and pavement design data with respect to present and future traffic condition.

CO4: Optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative.

CO5: Adopt new technology for pavement evaluation and maintenance with respect to field performance and funds available.

CO6: Provide the feedback data for updating the pavement performance monitoring system.

Module 1: (9 hours)

Components of a Pavement Management System (PMS): Definitions and structure of the system – Pavement Management Process and data requirements – Project and Network level needs; Pavement Investment Planning for Highways.

Pavement Condition Surveys and Rating Procedures: Assessment of pavement performance, Evaluation of pavement structural capacity, distress and safety, Calculation of Pavement Condition Index (PCI), combined measures of pavement quality, data management.

Module 2: (10 hours)

Non-destructive Testing: Pavement Deflection Measurement Devices – Factors affecting Deflection Values – Uses of NDT at Different Levels of Pavement Management.

Pavement Condition Prediction Models: Uses of Prediction Models - Techniques for development of pavement performance prediction models – AASTHO, CRRI and HDM models, computer applications.

Module 3: (10 hours)

Determining Present and Future Needs: Establishing criteria – determining the future needs, Rehabilitation and Maintenance strategies, developing combined programmes for maintenance and rehabilitation.

Network Level Pavement Management: Pavement Inventoryand condition at the last inspection – pavement condition forecasting – Budget Forecasting Localised maintenance and Rehabilitation Program – Development of annual and long range of work plans – PMS/GIS Interface.

Module 4: (10 hours)

Project Level Design: Framework for pavement design – Design objectives and constraints – Basic structural response models, Characterization of physical design inputs – Generating alternative pavement design – Economic evaluation of alternative design – Analysis of alternative design strategies – Selection of optimal design strategy.

Implementation: Major steps in implementing PMS – pavement construction management and pavement maintenance management – information's, research needs – cost and benefit of pavement management – future directions and need for innovations in pavement management.

References:

1. Shahin, M. Y., Pavement management for airport, roads and parking lots, Chapman and hall, 2005.
2. Yoder, E.J., and Witczak, Principles of Pavement Design, II Ed., John Wiley and Sons, 1975.
3. Woods, K.B., Highway Engineering Hand Book, McGraw Hill Book Co.

4. David Croney, The Design and Performance of Road Pavements, HMSO Publications, 2008.
5. Guidelines for Maintenance Management of Primary, Secondary and Urban Roads, Ministry of Road Transport and Highways, 2004.
6. Ralph C. G. Haas, W. Ronald Hudson and John Zaniewski, Modern Pavement Management, Krieger Publishing Company, 1994
7. Per Ullidtz, Pavement Analysis, Elsevier, Amsterdam,1998.
8. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements, 1988.
9. Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003.

CE4034D TRANSPORTATION INFRASTRUCTURE DESIGN

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Design the geometrical elements of midblocks and intersections.
CO2: Perform safety evaluation of design of existing and proposed geometric designs.
CO3: Plan and design the pedestrian, bicycle and parking facilities.
CO4: Have an understanding of terminal planning and design.

Module 1: (9 hours)

Design of Highways: Hierarchy of Highway System, Functions, Geometric Design Standards, Design Controls and Criteria – Vehicle, Driver and Traffic; Cross-Section Elements, Typical Sections, Design of the Alignment - Sight distance , Horizontal Alignment, Vertical Alignment, Integration, Optical Design, Landscaping and Safety Considerations, Evaluation and Design of existing geometrics.

Module 2: (10 hours)

Design of Intersections: Types of Intersections and Controls, Principles of Intersection Design; Design of At-Grade Intersections – Design Elements, Channelisation, Design using Templates; Rotary and Roundabout – Design, Capacity; Signalised Intersections – Benefits and Drawbacks, Warrants, Design; Signal Coordination – Methods, Design; Grade separated intersections – Warrants, Types, Geometric Standards, Spacing and Space controls, Ramps and Gore area design, Parking Facilities.

Module 3: (10 hours)

Pedestrian and Bicycle Facilities: Characteristics of Pedestrians and Bicycles, Issues Shared by Pedestrians and Bicycles, Pedestrian Facility Design - Walkways, Sidewalks, and Public Spaces, Pedestrian Facility Capacity and LOS, Signs and Pavement Markings , Intersections, Midblock Crossings, Flyovers and Subways; Bicycle Facility Design - Shared Roadways, Bike Lanes, Parking and Storage

Module 4: (10 hours)

Terminal Planning and Design: Terminal Functions, Analysis of Terminals, Process Flow Charts of Passenger and Goods Terminals, Terminal Processing Time, Waiting Time, Capacity and Level Of Service Concept, Study of Typical Facilities of Highway, Transit, Airport and Waterway Terminals, Concept of Inland Port.

References:

1. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers, 1987.
2. IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural and Urban Areas
3. Salter, R. J., Highway Traffic Analysis and Design, ELBS, 1996.
4. Edward K. Morlock, Introduction to Transportation Engineering and Planning, International Student Edition, McGraw-Hill Book Company, New York, 1992.
5. Joseph, De Chiara, Urban Planning and Design Criteria, Van Nostrand Reinhold, 1982.
6. Joseph De Chiara , Michael J. Crosbie, Mike Crosbie, Time-Saver Standards for Building Types, McGraw-Hill Professional, 2001.
7. Guide for the Planning, Design, and Operation of Pedestrian Facilities, AASHTO, 2004
8. Guide for the Development of Bicycle Facilities, AASHTO, 1999
9. Manual on Uniform Traffic Control Devices (MUTCD), 2009
10. Urban Intersection Design Guide, Texas Department of Transportation, 2005

CE4035D TRAFFIC FLOW MODELLING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: List the fundamental microscopic and macroscopic traffic flow characteristics and their relationships

CO2: Formulate and apply theories for describing and explaining the motion of a single vehicle and groups of vehicles.

CO3: Compare and contrast several different traffic analysis techniques.

CO4: Apply these techniques to a variety of highway facilities.

CO5: Analyze uninterrupted and interrupted traffic flows.

CO6: Calculate and report capacity and level of service for various facilities under different conditions.

CO7: Develop simulation models and to conduct experiments on simulation models.

Module 1: (9 hours)

Traffic Stream Characteristics and Description: Measurement, Description and Analysis of Microscopic and Macroscopic Characteristics of Flow, Speed and Density

Module 2: (10 hours)

Traffic Stream Models: Fundamental Equation of Traffic Flow, Speed-Flow-Density Relationships, Normalised Relationship;Continuum Flow Models - Simple Continuum Models, Shock Waves, High Order Models, Stochastic Continuum Models;Car-Following Models - Model Development, Linear and Non-Linear Car-Following Models, Stability Analysis,Car Following Experiments, Acceleration Noise; Two-Fluid Theory

Module 3: (10 hours)

Queuing Analysis: Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Models of Delay at Intersections and Pedestrian Crossings.

Module 4: (10 hours)

Simulation Models: Philosophy of Simulation Modelling, Formulation of Simulation Model, Methodology of System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments, Analysis of Simulation Data, Formulation of Simulation Problems in Traffic Engineering and Validation, Description of Some Available Models.

References:

1. TRB - SR No.165 - Traffic Flow Theory, Transportation Research Board, Washington, 1976.
2. Gartner N.H, Rathi A.J. and Messer C.J., Traffic Flow Theory – A Revised Monograph, Transportation Research Board, Washington, 1997.
3. May, A D., Traffic Flow Fundamentals, Prentice-Hall, NJ, 1990.
4. Drew, D.R., Traffic Flow Theory and Control, McGraw-Hill, New York, 1968.
5. TRB: Highway Capacity Manual, Transportation Research Board, Washington DC, 2000.
6. Wohl M. and Martin, B V., Traffic System Analysis for Engineers and Planners, McGraw-Hill, New York, 1967.
7. McShane W R &Roess R P, Traffic Engineering, Prentice-Hall, NJ, 2010.
8. Mannering, F.L. &Kilareski, W.P., Principles of Highway Engineering and Traffic Analysis, John Wiley & Sons, 2008.
9. Neylor, T.H. et al., Computer Simulation Techniques, John Wiley, 1966.

CE4036D ROAD SAFETY AND MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Identify the factors contributing to accidents.

CO2: Collect data pertaining to road crashes and prepare comprehensive crash database

CO3: Perform statistical analysis of crash data.

CO4: Formulate traffic management measures for accident prevention.

CO5: Perform road safety audit and prepare an audit report.

Module 1: (9 hours)

Introduction to road safety engineering - Over view of road safety - Global road safety scenario and pattern - global trends and projections - national and state road safety level - problems in road safety in developing countries- magnitude, socioeconomic and health effects.

Module 2: (10 hours)

Traffic Elements - Characteristics of Road user, Motor vehicle, Roadway- relationship between elements- human factors governing road user behavior- risk factors for traffic accidents- exposure to risk- crash involvement- crash severity- post crash injury outcomes

Module 3: (10 hours)

Analysis and prevention- Collection of accident data- Statistical methods for analysis of accident data- Speed in relation of safety- Weather and its effects on accidents- Vulnerable road users safety- parking influence on accidents- Traffic management measures for accident prevention- Legislation, Enforcement, Education and Propaganda- Formulating and implementing road safety policy.

Module 4: (10 hours)

Road safety improvement program - Road safety audit (RSA) - Procedure in road safety audit- design standards- audit tasks- stages of road safety audit- key legal aspects. Road design issues in RSA's – structuring and preparation of audit report.

References:

1. David L. Geotsc. Occupational Safety and Health for Technologists, Engineers and Managers. 5th Edition, 2004.
2. World Health Organization, Road Traffic Injury Prevention Training Manual, 2006.
3. Matson, M.T., Smith, S.W., Hurd, W.F. Traffic Engineering, McGraw-Hill Book Company Inc., London, 1955.
4. Fuller, R., Santos, J.A. Human Factors for Highway Engineers, Pergamon, 2002.
5. Khisty, C.J., Lall, B.K. Transportation Engineering- An Introduction, Third Edition, Prentice Hall of India, New Delhi, 2006.
6. Jason C.YU, Transportation Engineering- Introduction to Planning, Design, and Operations, Elsevier, 1982.
7. Kadiyali, L.R. Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi, 2009.
8. IRC: 103-1988, Guidelines for Pedestrian Facilities, Indian Roads Congress, New Delhi.
9. IRC: SP: 32-1988, Road Safety for Children (5-12 Years old), Indian Roads Congress, New Delhi.
10. IRC: SP: 44-1996, Highway Safety Code, Indian Roads Congress, New Delhi.
11. IRC: SP: 88-2010, Road Safety Audit Manual, Indian Roads Congress, New Delhi.

CE4037D ENVIRONMENTAL FORENSICS

Pre-requisites: CE2010D Environmental Studies

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Demonstrate knowledge in the different environmental acts and statues pertaining to Environmental forensics cases in India.

CO2: Advice on the scientific tools/techniques suitable for a particular environmental forensics investigation

CO3: Adopt proper sampling and testing method for Environmental forensics investigation.

CO4: Graduate will be able to lead an Environmental forensic investigation

Module 1: (13 hours)

Principles of in international environment law -liability principles-polluter pays principle, principle of preventive action-precautionary principle-principle of public trust.

Environmental redress mechanism in India-Constitutional provisions, IPC provisions, tort law provisions, Environmental (Protection) Act, 1986-Water (Prevention and Control of Pollution) Act, 1974 and corresponding rules -Air (Prevention and Control of Pollution) Act, 1981 and corresponding rules -The National Green Tribunal Act, 2010 -Other environment related rules at the national and state level- Case law.

Module 2: (13 hours)

Types of environmental forensic problem- Forensic techniques used in environmental litigation-Aerial photography, Remote sensing, Underground tank corrosion models, Inventory reconciliation, Chemical finger printing, Use of stable and radioactive isotopes, dendroecology, Microbial techniques-traditional microbial forensics, DNA Fingerprinting techniques, Use of Geographic Information System (GIS), Use of contaminant transport models, source apportionment methods-Chemical mass balance(CMB) modelling, Principle component analysis (PCA), Positive matrix factorization (PMF).

Module 3: (13 hours)

History, chemistry and transport of chlorinated solvents, petroleum hydrocarbons, crude oil and refined products, Transport in groundwater.

Environmental sampling and analysis for forensic applications -soil collection for chemical analysis, groundwater sampling, air sampling, analysis methods.

Indian Standards for sampling and testing –Air, Water and Soil. Standard protocol for environmental forensic investigation- INTERPOL procedure for typical cases.

References:

1. Sands, Philippe, Principles of International Environment Law, 2nd ed., Cambridge, UK: Cambridge University Press, 2003.
2. Morrison, Robert D, Environmental Forensics: Principles and Applications, CRC Press, 2000.
3. Hester, R. E and R. M. Harrison (Ed.), Environmental Forensics, RSC Publishing, 2008.
4. Murphy, Brian L. and Robert Morrison (Ed.), Introduction to Environmental Forensics, Elsevier Academic Press, Burlington, USA, 2007.
5. INTERPOL, Pollution crime forensic investigation manual (Vol 1&2), Lyon: INTERPOL General Secretariat, 2014
6. Website of the Ministry of Environment, Forest and Climate Change, Government of India.

CE4038D ENVIRONMENTAL RISK ANALYSIS

Pre-requisites: CE2010D Environmental Studies

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:
Students will be able to:
- CO1: Demonstrate knowledge in human health risk assessment and risk communication
- CO2: Carry out human health risk assessment or a given exposure scenario
- CO3: Carry out quantitative microbial risk assessment for a given exposure scenario
- CO4: Demonstrate knowledge in ecological risk assessment
- CO5: Demonstrate knowledge in industrial risk assessment.

Module 1: (13 hours)

Concepts of hazard and risk, environmental risk- non-carcinogenic and carcinogenic risks- NAS framework for human health risk assessment: hazard identification, dose-response assessment, exposure assessment, risk characterization- risk communication- carcinogenic and non- carcinogenic risk assessment- exposures via ingestion, inhalation, dermal uptake- bio-concentration- radiation risks- deterministic vs. probabilistic risk assessment

Module 2: (13 hours)

Quantitative Microbial risk assessment (QMRA)- microbial risk vs. chemical risk, dose-response models in QMRA- risk of infection, illness, fatality
Concept of DALY- calculation of DALY
Ecological Risk Assessment (EcoRA), USEPA's EcoRA framework- stressors- assessment endpoints- conceptual models- EcoRA vs. human health risk assessment.

Module 3: (13 hours)

Industrial Risk assessment –Hazop, Fault tree analysis, Event tree analysis, Cause-consequence analysis, reliability block diagrams, task analysis
Disaster Risk – Definition, significance, disaster risk reduction- resilience

References:

1. Lerche, Ian and Walter Glaesser, Environmental Risk Assessment: Quantitative measures, anthropological influences, human impact, Springer Publishers, 2010.
2. Robson, Mark, William Toscano (Ed.), Risk Assessment for Environmental Health, John Wiley and Sons Inc, 2007.
3. National Research Council, *Risk Assessment in the Federal Government: Managing the Process*, Washington, DC: The National Academies Press, 1983
4. WHO, Quantitative microbial risk assessment -Application for water safety management, Geneva: World Health Organization, 2016
5. Glenn W. Suter II, Ecological Risk Assessment (II Edition), Florida: CRC Press, 2006
6. Arnljot Høyland, Marvin Rausand, System Reliability Theory: Models and Statistical Methods, Wiley, 2009
7. Christian N Madu, Chu-Hua Kuei, Handbook of Disaster Risk Reduction & Management, Singapore: World Scientific Publishing, 2017

CE4039D ENVIRONMENTAL SYSTEM ANALYSIS

Pre-requisites: CE3009D Environmental Engineering I

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Define environmental systems and their boundaries

CO2: Optimize systems for a set of constraints and objectives

CO3: Determine the sensitivity of decisions and optimal solutions based on changes in constraints

CO4: Translate complex problems into mathematical frameworks, and define appropriate sets of solutions when there are multiple, competing objectives

Module 1: (13 hours)

The Systems Approach: Establishing Objectives, Decision Variables, and Constraints- Exploring Different Types and Scales of Systems- Solving Basic Linear Systems Problems- Graphing Decision Space and Objective Functions- Tragedy of the Commons as an Optimization Problem- Optimization models in waste water treatment- Microsoft Excel Solver- Slack and Surplus Variables- Basis and Non-Basis Variables- Discussion of solution algorithms- Problems with Many Decision Variables- Binding and Non-Binding Constraints- Finding New Optimum under Changing Constraints- Objective Function Sensitivity

Module 2: (13 hours)

Non-Linear Programming- Non-linear problems- Decision Analysis- Multi-criteria Decision Analysis - Solutions Using Alternate Objectives- Defining non-inferior sets (Pareto optimality)- Pareto optimality and tradeoff analysis- Trade-off Evaluation (Environmental, Economic, Social Criteria)- Weighting and Constraint Methods- Cost-Benefit Analysis- examples from environmental systems- Utility Scoring- Analytical Hierarchy Process- Matrix Method for generating scores and weights

Module 3: (13 hours)

Network Analysis- application to environmental systems- Dynamic Programming – Solving Multi-Stage/Multi-Decision Problems- Life Cycle Analysis as type of systems analysis- Wicked Problems- Optimization over time- discounting of future objectives- Environmental modeling under uncertainty- Monte-Carlo Simulation

Game theory- use in environmental decision making

References:

1. Revelle, C.S.; Whitlatch, E. E.; Wright, J. R.; Civil and Environmental Systems Engineering (2nd ed.), Prentice Hall, 2006
2. Haith, D. A. Environmental Systems Optimization. New York: John Wiley & Sons,1982.
3. Walter J. Weber, Jr, Environmental System and Processes- Principles, Modelling and design, New York: John Wiley & Sons,2001

CE4040D ADVANCED WASTE WATER ENGINEERING

Pre-requisites: CE4001D Environmental Engineering II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Graduates will demonstrate knowledge in advanced waste water engineering

CO2: Graduates will be able to suggest suitable method for treatment once the waste water characteristics are available

CO3: Graduates will be able to explain in detail the principles of different waste water treatment processes

CO4: Graduate will be able to design various units for advanced waste water treatment

Module 1: (13 hours)

Overview of Advanced Waste Water Treatment, Need for Advanced Waste Water Treatment, Purpose of Advanced Waste Water Treatment

Disinfection of waste water- Adsorption: Introduction, Fundamentals of adsorption, Type of adsorbents; Activated carbon adsorption

Softening, Iron and manganese removal, colour and odour removal

Membrane filtration: Microfiltration, Ultrafiltration, Nano filtration, Reverse Osmosis, Electrodialysis; Membrane Fouling

Module 2: (13 hours)

Ion exchange process- Introduction, Removal and recovery of heavy metals, Removal of nitrogen, Removal of phosphorus

Electro coagulation – Introduction to electrocoagulation, Factors affecting Electrocoagulation, design

Advanced Oxidation Processes- Theory of advanced oxidation, Types of oxidizing agents, ozone based and non ozone based processes; Application in industries – textile, petroleum

Module 3: (13 hours)

Anaerobic digestion: concepts of suspended growth, contact process, attached growth, anaerobic biological contractors, anaerobic expanded/fluidized bed reactors, expanded growth, Design of UASB and its modifications

References:

1. Metcalf & Eddy Inc., George Tchobanoglous, H. David Stensel, Ryujiro Tsuchihashi, Franklin L. Burton , Wastewater Engineering: Treatment and Resource Recovery, New York, USA: McGraw-Hill Education, 2014
2. Karia, G. L., and R. A. Christian. Wastewater treatment: Concepts and design approach, New Delhi: PHI Learning Pvt. Ltd., 2013
3. The Central Public Health and Environmental Engineering Organisation(CPHEEO), Manual on Sewerage and Sewage Treatment, Ministry of Urban Development, Government of India
4. Nath, Kaushik, Membrane separation processes, New Delhi: PHI Learning Pvt. Ltd., 2017

CE4041D GEOINFORMATICS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Understand map projections and coordinate systems to select appropriate system for intended application

CO2: Assess and manage the geospatial data quality

CO3: Carry out various geospatial analysis using raster geoprocessing utilities

CO4: Carry out various geospatial analysis using vector geoprocessing utilities

CO5: Prepare digital terrain model

Module 1: (11 hours)

Introduction to GIS

Maps – Types – Characteristics – Coordinate systems – Map projections – Datums – Definition of GIS – Evolution – Components of GIS – DBMS – Geospatial data representation (Raster, Vector, Object-Oriented)

Module 2: (14 hours)

Geospatial Data Quality

Sources of geospatial data and attribute data – Geospatial data quality concepts – Components of geospatial data quality – Assessment of data quality – Managing spatial data errors – Geospatial data standards

Raster Geoprocessing

Characteristics of raster geoprocessing – Acquiring and handling raster geospatial data – Raster geospatial data analysis – Output functions of raster geoprocessing

Module 3: (14 hours)

Vector Geoprocessing

Characteristics of vector geoprocessing – Vector data input functions – Non-topological GIS analysis functions – Topological functions (feature based, layer based) – Vector geoprocessing output functions

Digital Terrain Modelling

Definitions and terminology – approaches to digital terrain data sampling – acquisition of digital terrain data – Data processing, analysis and visualization – Applications of Digital terrain models

References:

1. Lo C. P and K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Pearson Education, Second edition, 2016
2. Michael N. Demers, Fundamentals of Geographic Information Systems, Wiley India Pvt. Ltd, Third Edition, 2008
3. Peter. A. Burrough and Rachel A. Mcdonnell, Principles of Geographical Information Systems, Oxford University Press, USA, Second Edition, 1998
4. Paul A. Longley, Michael Goodchild, David J. Maguire and David W. Rhind (Eds.), Geographical Information Systems: Principles, Techniques, Management and Applications, John Wiley and Sons, Second Edition, 2005

CE4042D ADVANCED STRUCTURAL ANALYSIS

Pre-requisites: CE4002D Structural Analysis III

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Analyse special types of structures - beams on elastic foundation, curved beams and beams subjected to nonsymmetrical bending

Co2: Formulate and analyze finite element model of a physical system

Module 1: (14 hours)

Beams on elastic foundation: Modelling of foundations-differential equation of equilibrium of beam on elastic foundation-solution-infinite beam under single concentrated load-Infinite beam under a segmental distributed load-Infinite beam under a single applied couple-semi-infinite beam with point load and moment at one end-beam of finite length with twopoint symmetrically located.

Module 2: (14 hours)

Beams curved in plan: Analysis of cantilever beam curved in plan - analysis of circular beams over simple supports.

Nonsymmetrical bending of straight beams: Shear centre - a review, symmetrical and nonsymmetrical bending - bending stresses in beams subjected to nonsymmetrical bending - deflections of straight beams subjected to unsymmetrical bending - fully plastic load for unsymmetrical bending.

Module 3: (10 hours)

Introduction to finite element method: Discretization of a structure-displacement function-truss element-beam element-plane stress and plane strain-triangular elements.

Isoparametric Formulations: concept of isoparametricformulation, plane rectangular elements, Jacobian, numerical integration.

References:

1. Boresi, A. P., and Sidebottom, O. M., Advanced Mechanics of Materials, John Wiley and Sons, 2003.
2. Srinath, L. S., Advanced Mechanics of Solids, Tata McGraw Hill, New Delhi, 2009.
3. Timoshenko, S., Strength of Materials, Part II, CBS Publishers, New York, 2002.
4. Cook, R.D., et al, Concepts and Applications of Finite Element Analysis, John Wiley, 1992.
5. Chandrupatla, T.R., and Belegundu, A.D., Introduction to Finite Elements in Engineering, Pearson education Ltd, 2014.
6. Krishnamoorthy, C.S., Finite Element Analysis – Theory and Programming, Tata McGraw Hill,New Delhi, 1995.

CE4043D ADVANCED STEEL DESIGN

Pre-requisites: CE3007D Structural Design II

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Understand the provisions in Indian standard codes of practice for the design of various steel structures

CO2: Design various types of steel structures using hot rolled sections

CO3: Understand the provisions in Indian railway loading standards for the design of railway bridges

CO4: Design structures using light gauge steel sections

Module 1: (13 hours)

Gantry Girder: Design of gantry girder – gantry to column connections.

Water Tanks: Design of rectangular, pressed steel tanks – design of suspended bottom tanks – cylindrical tank with hemispherical bottom – design of staging.

Module 2: (13 hours)

Plate girder bridges: Plate girders – loads – equivalent uniformly distributed loads – Indian railway code of practice – design of plate girder bridges – bearings.

Light gauge members: Light gauge sections – design considerations – allowable stresses – buckling, design of compression members, tension members and laterally supported beams – connections.

Module 3: (13 hours)

Chimneys: Design of self-supporting chimney – design principles of guyed chimney.

Bunkers and Silos: Introduction– Janssen‘s theory– Airy‘s theory– design criteria.

Transmission Towers: Introduction–loads on towers– analysis–design of members and foundation.

References:

1. Subramanian, N., Design of Steel Structures, Oxford University Press, 2008.
2. Bhavikatti, S. S., Design of Steel Structures, I K International Publishing House (P) Ltd, 2009.
3. Duggal, S. K., Limit State of Design of Steel Structures, Tata McGraw Hill,New Delhi,2010.
4. Ramchandra , Design of Steel Structures Vol I and II, Standard book house, New Delhi,1991.
5. Dayaratnam, P., Design of Steel Structures, Wheeler,1998.
6. Raghupathi, M., Design of Steel Structures, Tata McGraw Hill, New Delhi,1985.
7. Lin and Breslar, Design of Steel Structures, John Wiley and Sons, 1963.
8. Relevant BIS codes

CE4044D SEISMIC DESIGN OF STRUCTURES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course outcomes:

Students will be able to:

CO1: Assess the need for seismic analysis for a given Civil Engineering system

CO2: Perform seismic analysis of a structure

CO3: Carry out design and detailing of different types of structure as per latest IS code of practice

Module 1: (13 hours)

Introduction to Engineering seismology: Nature of earth ground motion - causes of earthquake - seismic waves-primary and secondary waves – Raleigh wave - love wave – earthquake damage mechanism- magnitude of earthquake – intensity of earthquake- seismic zoning map of India- response of structure to earthquake motion.

Concept of seismic design: Approach to seismic design – general principles of a seismic design - relevant IS codes – conceptual design- design earthquake loads- load combinations and permissible stresses - equivalent static analysis – vertical distribution of seismic forces and horizontal shears.

Module 2: (13 hours)

Dynamic analysis: Seismic response of structures – systems with single degree of freedom – systems with multiple degrees of freedom – continuous system – modeling of structures – equation of motion – periods and modes of vibration - design spectrums – modal combination

Guide lines for seismic design: Ductile detailing for seismic design - improving seismic behaviour of masonry, timber and steel buildings.

Module 3: (13 hours)

Seismic design: Seismic design of water tanks– elevated tower supported tanks- hydrodynamic pressure in tanks – examples-seismic design of towers – stack like structures – chimneys – seismic design principles of retaining walls – concept of seismic design of bridges – seismic design of bearings.

References:

1. Agarwal, P., andShirkhande, M., Earthquake Resistant Design of structures, Prentice-Hall of India, 2006.
2. Duggal, S. K., Earthquake Resistant Design of structures, Oxford University Press, 2007.
3. Datta, T.K., Seismic Analysis of Structures, John Wiley and sons (Asia) Pvt Ltd, 2010.
4. Brijesh, C.,Chandasekaran, Krishna Jai, A.R., Elements of Earthquake Engineering, South Asian Publishers Pvt.Ltd, 1994.
5. Gupta, A., Response Spectrum Method in Seismic Analysis and Design of Structures, CRC press, INC, 1992.
6. Relevant BIS Codes

CE4045D FRACTURE MECHANICS

Pre-requisites: CE2001D Mechanics of Solids or Equivalent Course

L	T	P	C
3	0	0	3

Total Hours: 39
Course Outcomes:

Students will be able to:

CO1: Solve problems of fracture mechanics using Energy approach, SIF, J-integral approach and COD approach
CO2: Determine fracture toughness experimentally
CO3: Analyse problems involving fatigue
CO4: Solve practical problems using the concepts of fracture mechanics

Module 1: (13 hours)

Introduction: Significance of fracture mechanics – Griffith energy balance approach – Irwin's modification to Griffith theory – stress intensity approach – crack tip plasticity – fracture toughness – subcritical crack growth – influence of material behavior – I, II &III modes – mixed mode problems.

Linear Elastic Fracture Mechanics (LEFM): Elastic stress field approach – mode I elastic stress field equations – expressions for stresses and strains in the crack tip region – finite specimen width – superposition of stress intensity factors (SIF) – SIF solutions for well known problems such as centre cracked plate – single edge notched plate and embedded elliptical cracks.

Crack tip Plasticity: Irwin plastic zone size – Dugdale approach – shape of plastic zone – state of stress in the crack tip region – influence of stress state on fracture behavior.

Module 2: (13 hours)

Energy Balance Approach**:** Griffith energy balance approach – relations for practical use – determination of SIF from compliance – slow stable crack growth and R-curve concept – description of crack resistance.

LEFM Testing: Plane strain and plane stress fracture toughness testing – determination of R-curves – effects of yield strength and specimen thickness on fracture toughness – practical use of fracture toughness and R-curve data.

Elastic Plastic Fracture Mechanics (EPFM): Development of EPFM, J-integral – crack opening displacement (COD) approach – COD design curve – relation between J and COD – Tearing modulus concept – Standard J_{IC}test and COD test.

Module 3: (13 hours)

Fatigue Crack Growth:Description of fatigue crack growth using stress intensity factor – effects of stress ratio and crack tip plasticity – crack closure, prediction of fatigue crack growth under constant amplitude and variable amplitude loading – fatigue crack growth fromnotches – the short crack problem.

Sustained Load Fracture: Time-to-failure (TTF) tests – crack growth rate testing –experimental problems – method of predicting failure of a structural component – practical significance of sustained load fracture testing .

Practical Problems: through cracks emanating from holes – corner cracks at holes – cracks approaching holes – fracture toughness of weldments.

References:

1. Kumar, P. Elements of Fracture Mechanics, Tata McGraw Hill, 2009.
2. Maiti, S. K., Fracture Mechanics: Fundamentals and applications, Cambridge, 2015.
3. Jin, Z.H., Sun, C.T., Fracture Mechanics,Academis Press, 2005.
4. Anderson, T.L., Fracture Mechanics: Fundamentals and applications, CRC Press, 2011.
5. Broek, D. Elementary Engineering Fracture Mechanics, Sijthoff&Noordhoff International Publishers, 1982.
6. Janssen, M., Zuidema, J. and Wanhill, R., Fracture Mechanics, Spon Press, 2004.
7. Knott J.F, Fundamentals of Fracture Mechanics, Butterworth & Co, 1973.

CE4046D FORENSIC ENGINEERING AND REHABILITATION OF STRUCTURES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:
CO1: Acquire knowledge regarding failure of structures.
CO2: Acquire knowledge regarding durability of RCC structures.
CO3: Familiarize the modern techniques of retrofitting.

Module 1: (13 hours)

Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – case studies – learning from failures – causes of distress in structural members – design and material deficiencies – over loading - Diagnosis and Assessment of Distress: Visual inspection – non destructive tests – ultrasonic pulse velocity method – rebound hammer technique – ASTM classifications – pullout tests – Bremor test – Windsor probe test – crack detection techniques.

Module 2: (13 hours)

Case studies: Single and multistorey buildings – Fibreoptic method for prediction of structural weakness - Environmental Problems and Natural Hazards: Effect of corrosive, chemical and marine environment – pollution and carbonation problems.

Durability of RCC structures: Damage due to earthquakes and strengthening of buildings – provisions of BIS Codes.

Module 3: (13 hours)

Modern Techniques of Retrofitting: Structural first aid after a disaster – guniting, jacketing – use of chemicals in repair – application of polymers – ferrocement and fiber concretes as rehabilitation materials – strengthening by pre-stressing – case studies – bridges – water tanks – cooling towers – heritage buildings – high rise buildings.

References:

1. Dovkaminetzky., Design and Construction Failures, Galgotia Publication, New Delhi,2001.
2. Jacob, F., and Kenneth, L C., Structural Failures, Wiley Europe, 1997.

CE4047D DYNAMICS OF STRUCTURES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Mathematically model a structural system for dynamic analysis

CO2: Carry out free vibration analysis of single degree of freedom

CO3: Analyse a single degree of freedom systems to subjected to harmonic loading, periodic loading and general dynamic loadings

CO4: Perform free vibration and forced vibration analyses of multi degree of freedom systems

CO5: Learn to analyse a continuous system both as a distributed parameter system and as an approximate discrete parameter system with multiple degrees of freedom.

Module 1: (10 hours)

Introduction to Dynamics of Structural Systems: continuous systems and discretisation; significance of single degree of freedom system in dynamic analysis of structural systems.

Free Response of Singe-Degree-of-Freedom Linear Systems: General considerations; characteristics of discrete system components; differential equation of motion of second-order linear systems; free vibration response of undamped and damped single degree of freedom systems; logarithmic decrement; critical, under- and over-damped systems.

Module 2: (10 hours)

Forced Response of Singe-Degree-of-Freedom Systems: Response of second-order systems to harmonic excitation; harmonic motion of support; complex vector representation of harmonic motion; vibration isolation; vibration measuring instruments; energy dissipation and structural damping; superposition and response to periodic excitation; Fourier series; the unit impulse and impulse response; unit step function and step response; response to arbitrary excitation; the convolution integral; general system response.

Module 3: (10 hours)

Multi-Degree-of-Freedom Systems: Equations of motion; generalised coordinates; matrix formulation; stiffness and mass matrices; linear transformations and coupling; undamped free vibration; eigenvalue problem; natural frequencies and mode shapes; orthogonality of modal vectors; expansion theorem; response to initial excitation; modal analysis; solution of eigenvalue problem by matrix iteration; power method; Rayleigh’s coefficient; general response of discrete linear systems; modal analysis.

Module 4: (9 hours)

Continuous System: Relation between discrete and continuous system; boundary value problem; free vibration; eigenvalue problem; axial vibration of rods; bending vibration of beams; orthogonality of natural modes; expansion theorem; Rayleigh’s quotient; response of systems by modal analysis; introduction to approximate methods of analysis of continuous systems; Rayleigh-Ritz method; finite element method.

Introduction to Analytical Dynamics: Work and energy; principle of virtual work; D’Alembert’s principle; Lagrange equations of motion.

References:

1. Clough,R.W. and Penzien, J., Dynamics of structures, McGraw Hill, 1993.
2. Chopra, A.K., Dynamics of structures - Theory and Application to Earthquake Engineering, Prentice Hall of India, 1996.
3. IS 1893 - Criteria for Earthquake Resistant Design of Structures, 2002.
4. SP 22: Explanatory Handbook on Codes for Earthquake Engineering.
5. Meirovitch L., Elements of Vibration Analysis, Mc.Graw Hill, 1986.
6. Thomson W.T., Theory of Vibration with Applications, Pearson Education Inc., 1998.
7. Craig, Jr. R.R., Structural Dynamics, John Wiley, 1981.
8. Hurty, W.C. and Rubinstein M.F., Dynamics of Structures, Prentice Hall, 1964.

CE4048D MAINTENANCE AND REHABILITATION OF CONSTRUCTED FACILITIES

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Course Outcomes:

Students will be able to:

CO1: Analyse the cause of damage and deterioration of structures, scientific principles of assessing the condition of damaged structures

CO2: Suggest suitable repair, strengthening, stabilization, and protection methods for satisfactory performance

CO3: Evaluate the various advanced techniques in maintenance and rehabilitation of different types of buildings.

Module 1: (13 hours)

Diagnosis and Assessment of Concrete Structures

Damages of structures-Earth quake, Hurricanes, Fire, Settlement, Impact, Fatigue , Durability of concrete -Corrosion- Shrinkage- Moisture- Deterioration- Termites- Acid /Alkali- Vandalism; Assessment of concrete structures- need for assessment- art of assessment – principles of investigation ; techniques of assessment- physical tests-chemical and electrochemical tests –Ground penetrating radar- Impact echo method-Nondestructive testing of concrete- Pull out test- internal fracture- pull off tests- break off tests- penetration tests- Infrared tomography- sonic integrity testing-

Module 2: (11 hours)

Rehabilitation of Concrete Structures

Polymer for concrete repair; repair to cracked concrete- spalled concrete- hand applied repairs; spared concrete- large volume repair; leak sealing- surface coatings; under water repair- repair of concrete floor; concrete- strengthening and stabilization- Materials used for Waterproofing&Repair systems-selection of water proofing materials- corrosion treatment- testing techniques – crack bridging

Module 3: (15 hours)

Restoration of old monuments- maintenance and repair of other types of structures (brick, steel, wood etc.)- fire damaged structures- their repair- foundation – failures and remedial measures-maintenance issues, EarthquakeBehavior, Design and Strengthening of Masonry Structures-Masonry building systems – Seismic responses

References:

1. Diagnosis and assessment of concrete structures- State of art report CEB
2. Concrete Repair and Maintenance Illustrated, Peter H. Emmons, R.S. Means Company Inc., Kingston, MA, USA.
3. Repair, Protection, and Waterproofing of Concrete Structures, P.H. Perkins, Taylor and Francis, 2006
4. Assessment and Renovation of Concrete Structures, Ted Kay, Longman Scientific Technical, USA
5. Concrete Structures – Protection, Repair, and Rehabilitation, Dodge Woodson, Butterworth-Heinemann, Elsevier Publications
6. CPWD Maintenance Manual, Central Public Works Department, New Delhi, 2012
7. Construction Materials: Their Nature and Behaviour, Eds. J.M. Illston and P.L.J. Domone, 3rd ed., Spon Press, 2001
8. The Science and Technology of Civil Engineering Materials, J.F. Young, S. Mindess, R.J. Gray & A. Bentur, Prentice Hall, 1998.