

Regulation R21,  
Department of Civil Engineering,  
Mahindra University,  
Ecole Centrale School of Engineering,  
Bahadurpally, Hyderabad 500043

## **COURSE CATEGORIES**

<b>S. No.</b>	<b>Category</b>	<b>Description</b>
<b>1</b>	<b>CH – Chemistry</b>	<b>Courses in Chemistry.</b>
<b>2</b>	<b>PH – Physics</b>	<b>Courses in Physics</b>
<b>3</b>	<b>ES – Engineering Science</b>	<b>Courses in Engineering Sciences</b>
<b>4</b>	<b>CE – Civil Engineering</b>	<b>Courses related to Civil Engineering</b>
<b>5</b>	<b>CS – Computer Science</b>	<b>Courses in Computer Science and Technology</b>
<b>6</b>	<b>EE – Electrical Engineering</b>	<b>Courses of Electrical Engineering</b>
<b>7</b>	<b>ME – Mechanical Engineering</b>	<b>Courses in Mechanical Engineering</b>
<b>8</b>	<b>HS – Humanities and Social Sciences</b>	<b>Courses in Language, Culture, Philosophy, etc.</b>
<b>9</b>	<b>SE – Society &amp; Enterprise</b>	<b>Includes projects and courses in Media, Industrial Engineering, Management, Finance, etc.</b>
<b>10</b>	<b>PR – Projects</b>	<b>Includes third year and final year projects</b>

## CURRICULUM

Semester 1						
	Code	Course	L	T	P	Credits
1	MA 1101	Calculus and ODE	4	1	0	5
2	CH 1101	Chemistry – I	2	1	0	3
3	EE 1101	Introduction to Electrical Engineering	2	1	2	2
4	EE 1102	Electronics	2	1	2	2
5	CE 1101	Earth and Environmental Sciences	2	0	0	2
6	ME 1101	Engineering Drawing	0	0	3	1.5
8	ME 1102	Mechanics	2	1	0	3
9	HS 1101	English	3	0	0	3
10	HS 1102	Media Project	0	0	3	1.5
11	HS 1103	French language & Culture – I	0	2	0	0.5
12	HS 1104	Introduction to Entrepreneurship	0	0	3	1
		<b>Total Credits</b>				<b>24.5</b>
		Total contact hours				32
Semester 2						
	Code	Course	L	T	P	Credits
1	MA 1202	Linear Algebra and complex analyses	3	1	0	4
2	PH 1201	Physics – I	2	1	2	4
3	CH 1202	Chemistry – II	2	0	2	3
4	CS 1201	Introduction to Computer Science	2	1	2	4
5	ME 1203	Workshop Practice	0	0	2	1
6	ME 1204	Thermodynamics	2	1	0	3
7	CE 1202	Building Materials	2	0	0	2
8	HS 1204	Entrepreneurship practice	0	0	2	1
9	HS 1205	Professional Ethics	0	1	0	1
10	HS 1206	French language & Culture – II	0	2	0	0.5
		<b>Total Credits</b>				<b>23.5</b>
		Total contact hours				30

<b>Semester 3</b>						
	<b>Code</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1	MA 2103	Probability and Statistics	3	1	0	4
2	PH 2102	Physics – II	3	1	2	5
3	CS 2102	Data Structures	2	2	2	5
4	CE 2103	Mechanics of Materials	3	1	0	4
5	CE 2104	Building Drawing	0	0	4	2
6	CE 2105	Geology Lab	0	0	2	1
7	HS 2107	Lean Startup	0	0	3	1
8	HS 2108	French*/Other Foreign Language – III	0	2	0	0.5
9	HS 2109	Economics	3	0	0	1.5
		Total Credits				<b>24</b>
		Total Contact hours				32.5
<b>Semester 4</b>						
	<b>Code</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1	MA 2204	Numerical Methods	3	0	2	4
2	CE 2206	Structural Analysis	3	0	2	4
3	CE 2207	Engineering Surveying	3	0	2	4
4	CE 2208	Fluid Mechanics	3	0	2	4
5	CE 2209	Concrete Technology	2	0	2	3
6	HS 2210	Design Thinking	1	0	2	2
7	HS 2211	French Language & Culture – IV*/or other	0	2	0	0.5
8	HS 2212	Financial accounting	3	0	0	1.5
		Total Credits				<b>23</b>
		Total contact hours				32

<b>Semester 5</b>						
	<b>Code</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1	CE 3110	Transportation Engineering	3	0	2	4
2	CE 3111	Construction Technology	2	0	0	2
3	CE 3112	Computing Lab	0	0	4	2
4	CE 3113	Reinforced Concrete Design	3	1	0	4
5	CE 3114	Soil Mechanics	3	0	2	4
6	CE 3115	Water Resources Engineering	3	0	0	3
7		HSS + Mgmt. - Elective – I	2	0	0	2
8	HS 3113	French Language & Culture – V	0	2	0	0.5
		Total Credits				<b>21.5</b>
		Total contact hours				27
<b>Semester 6</b>						
	<b>Code</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1	PR 3201	Third Year Team Project	0	0	6	3
2	CE 3216	Design of Steel Structures	3	1	0	4
3	CE 3217	Environmental Engineering	3	0	2	4
4	CE 3218	Foundation Engineering	3	0	0	3
5		Core Elective I	3	0	0	3
6	CE 3219	Hydraulic Machines	2	0	0	2
7	HS 3214	Introduction to professional development and employability skills	2	0	0	2
8		HSS + Mgmt. - Elective – II	2	0	0	2
9	HS 3215	French Language & Culture – VI	0	2	0	0.5
		Total Credits				<b>23.5</b>
		Total contact hours				29

<b>Semester 7</b>						
	<b>Code</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
	PR 4102	Final year project	0	0	6	3
1	CE 4120	Remote Sensing and GIS	2	0	0	2
2	CE 4121	Construction Planning and Management	3	0	0	3
3		Core Elective II	3	0	0	3
4		Open Elective I	3	0	0	3
5		HSS + Mgmt. - Elective – III	2	0	0	2
6	HS 4116	French Language & Culture – VII	0	2	0	0.5
		Total Credits				<b>16.5</b>
		Total contact hours				21
<b>Semester 8</b>						
	<b>Code</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1	PR 4203	Final year project	0	0	18	9
2		Core elective III	3	0	0	3
3		Open elective II	3	0	0	3
4	HS 4317	French Language & Culture -VIII	0	2	0	0.5
		Total Credits				<b>15.5</b>
		Total Contact hours				26

### List of Core Electives (Structural Engineering Basket)

S.No.	Code	Course	L	T	P	Credits
1	CE 3250	Advanced Structural Analysis	3	0	0	3
2	CE 3251	Advanced Concrete Technology	3	0	0	3
3	CE 4152	Dynamics of Structures	3	0	0	3
4	CE 4153	Prestressed Concrete	3	0	0	3
5	CE 4254	Introduction to Structural Health Monitoring	3	0	0	3
6	CE 4255	Introduction to Finite Element Analysis	3	0	0	3

### List of Core Electives (Transportation Engineering Basket)

S.No.	Code	Course	L	T	P	Credits
1	CE 3256	TE - II (Railways, Airports & Harbour Engg.)	3	0	0	3
2	CE 3257	Urban Transportation Planning	3	0	0	3
3	CE 4158	Transport and Environment	3	0	0	3
4	CE 4159	Traffic Engineering and Management	3	0	0	3
5	CE 4260	Pavement Analysis and Design	3	0	0	3
6	CE 4261	Intelligent Transportation System	3	0	0	3

### List of Core Electives (Geotechnical Engineering Basket)

S.No.	Code	Course	L	T	P	Credits
1	CE 4162	Geosynthetics and reinforced soil structures	3	0	0	3
2	CE 4163	Advanced foundation engineering	3	0	0	3
3	CE 4264	Ground improvement techniques	3	0	0	3
4	CE 4265	Soil structure interaction	3	0	0	3

## List of Open Electives (Semester 7 and 8)

S.No.	Code	Course	L	T	P	Credits
1	CE 4066	Pavement Material Characterization and construction	3	0	0	3
2	CE 4067	Airport Planning and Design	3	0	0	3
3	CE 4068	Advanced Soil Mechanics	3	0	0	3
4	CE 4069	Environmental Geotechnics	3	0	0	3
5	CE 4070	Geotechnical Earthquake Engineering	3	0	0	3
6	CE 4071	Risk assessment and Management in Geotech. Engg.	3	0	0	3
7	CE 4072	Rock Mechanics	3	0	0	3
8	CE 4073	Soil Dynamics and Machine Foundations	3	0	0	3
9	CE 4074	Introduction to Continuum Mechanics	3	0	0	3
10	CE 4075	Introduction to Fracture Mechanics	3	0	0	3
11	CE 4076	Earthquake Engineering	3	0	0	3
12	CE 4077	Sanitary Engineering and Design	3	0	0	3
13	CE 4078	Advanced Waste Water Treatment and Design	3	0	0	3
14	CE 4079	Environmental Impact Assessment	3	0	0	3
15	CE 4080	Industrial Waste Management	3	0	0	3
16	CE 4081	Design of Environmental Engineering Structures	3	0	0	3
17	CE 4082	RS and GIS for Environmental Engineering	3	0	0	3
18	CE 4083	Sustainable and Recycled Materials	3	0	0	3
19	CE 4084	Advanced Steel Structures	3	0	0	3
20	CS 3013	Machine learning	2	0	2	3
21	CS 4057	Deep Learning	3	0	0	3
22	CS 4060	Object oriented Programing	3	0	0	3
23	ME 4052	Introduction to Operation Research	3	0	0	3
24	ME 4060	Alternative Energy Sources	3	0	0	3



25	ME 4069	Computational Fluid Dynamics	3	0	0	3
26	ME 4070	Robotics: Dynamics and Control	3	0	0	3
27	MA 4050	Numerical Linear Algebra	3	0	0	3
28	MA 4051	Meshfree Methods	3	0	0	3
29	MA 4052	Boundary Element Method and Boundary Integral Equations	3	0	0	3
30	MA 4053	PDE Based Image Processing	3	0	0	3
31	MA 4054	Topology and Operator Theory	3	0	0	3
32	MA 4055	Infinite dimensional Control Theory	3	0	0	3
33	MA 4056	Bayesian Statistics	3	0	0	3
34	MA 4057	Financial Mathematics	3	0	0	3

**List of HS Electives (for semesters 5,6, and 7):**

S.No.	Code	Course	L	T	P	Credits
1	HS 5000	Selections from World Literature	2	0	0	2
2	HS 5001	Business Communication	2	0	0	2
3	HS 5002	Visual Story Telling	2	0	0	2
4	HS 5003	Introduction to Culture Studies	2	0	0	2
5	HS 5004	Literature and Visual Arts	2	0	0	2
6	HS 5005	Cinema and Philosophy	2	0	0	2
7	HS 5006	The Humanities for a Critical Understanding of the World	2	0	0	2
8	HS 5007	Academic Writing	2	0	0	2
9	HS 5008	Urban Studies: Reading the City	2	0	0	2
10	HS 5009	Contemporary Shakespeare: Readings and Adaptations	2	0	0	2
11	HS 5010	Philosophical Arguments	2	0	0	2

## **Semester-wise Course Descriptions**

**Course Code:** MA 1101  
**Course Name:** Calculus and ODE  
**Credits:** 4 (3-1-0)  
**Course Position:** Semester 1

**Course Content:**

**Module 1. Single variable calculus**

Limit, Continuity, Integration and its Applications, Polar Coordinates, Differentiability, Applications of Differentiation, Mean value theorem and its Applications, Curve Sketching, Indeterminate Forms, Taylor's and Maclaurin's theorems, Fundamental Theorem of Calculus.

**Module 2. Functions of Several Variables**

Limit, Continuity, Total Differential, Extrema of functions, Lagrange multiplier method, Double and Triple integrals, Change of Order of Integration.

**Module 3. Vector Calculus**

Gradient, Divergence and Curl, Line, Surface and Volume Integrals, Theorems of Green, Stokes and Gauss and their applications.

**Module 4. Infinite Series**

Sequences, Convergence and Divergence of a series, Tests for Convergence, Conditional and Absolute Convergence, uniform convergence of sequence of functions.

**Module 5. Ordinary Differential Equations**

The existence and uniqueness theorem on the general first order differential equations (statement, without proof, with some simple examples). Variable separable method, reducible to variable separable. Exact differentiable equations, integrating factors. Linear differential equations, Bernoulli's equation. The general solution of the second order linear homogeneous equations with constant coefficients. Undetermined coefficients, Variation of parameters. Cauchy problem for differential equation systems. Existence theorem (without proof), differential linear systems with constant coefficients. Geometric study in phase plane of simple equations, orthogonal polynomials.

**Textbooks:**

1. Tom M. Apostol, One Variable Calculus, with an Introduction to Linear Algebra (Text Book for First, Second and Fifth Modules)
2. Tom M. Apostol, Multi-Variable Calculus and Linear Algebra, with Applications to Differential Equations and Probability (Text Book for Third and Fourth Modules)
3. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications (Reference Book)

4. E. Kreyszig, Advanced engineering mathematics, John Wiley (1999). \* George B. Thomas, Jr., Maurice D. Weir, Joel Hass, Thomas' Calculus
5. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005).

**Course Code:** CH 1101  
**Course Name:** Chemistry – I (Physical and Analytical Chemistry)  
**Credits:** 3 (2-1-0)  
**Course Position:** Semester 1

**Course Content:**

**Module 1:** Atomic structure and periodic properties (6 lectures): Wave-particle duality. Schrodinger equation. Principles of quantum mechanics. Particle in a one-dimensional box solutions and its applications. Hydrogen atom wave functions. Shape and size of atomic orbitals. Multi-electron atoms – shielding – effective nuclear charge – orbital penetration. Periodic table and periodic properties of elements: electronic configuration, ionization energy and electron affinity.

**Module 2:** Chemical bonding and intermolecular interactions (8 lectures): Molecular orbitals as linear combinations of atomic orbitals. Molecular orbital energy level diagrams of homonuclear and heteronuclear diatomic molecules - electronegativity. Multi-atomic molecules, molecular geometry and symmetry. Crystal field theory of transition metal ions. Band theory of solids. Molecular properties: Dipole moment and Polarizability. Intermolecular interactions: dipolar and van der Waal's interactions.

**Module 3:** Analytical methods (10 lectures): Theoretical background of UV-Visible Spectroscopy, Infrared and Raman spectroscopy, Microwave spectroscopy, NMR spectroscopy and magnetic resonance imaging. Introduction to surface analytical techniques: X-ray photoelectron Spectroscopy, Atomic force microscopy.

**Module 4:** Structure determination using spectroscopic methods (6 lectures): Introduction to chemical analysis of organic molecules. Elemental analysis and Mass spectrometry. Structural elucidation of simple organic molecules using combination of different spectroscopic data.

**Textbooks:**

1. Atkin's Physical Chemistry; 10<sup>th</sup> edition; Peter Atkins and Julio De Paula; ISBN 978-0-19-954337-3
2. Organic Chemistry; Jonathan Clayden, Nick Greeves and Stuart Warren; ISBN: 978-0-19-927029-3
3. Fundamentals of Molecular Spectroscopy; 4<sup>th</sup> edition; Colin N. Banwell and Elaine M. McCash; ISBN-13: 978-9352601738
4. Organic Spectroscopy; 3<sup>rd</sup> Edition; William Kemp; ISBN 978-1-4039-0684-7

**Course Code:** EE 1103  
**Course Name:** Introduction to Electrical Engineering  
**Credits:** 2 (2-1-2)  
**Course Position:** Semester 1

**Course Content:**

**Module 1:** Electrical Quantities and Circuit Elements; Circuit Analysis: nodal and mesh analyses, superposition and linearity, network simplification;

**Module 2:** Network Graphs: nodal analysis using reduced incidence matrix, mesh analysis using fundamental circuit matrix, Tellegen's theorem;

**Module 3:** Sinusoidal Steady-State Analysis: nodal and mesh analyses using phasor method, Thevenin's theorem, maximum-power conditions; Response to Simple Networks: forced, natural and total responses in RLC networks;

**Module 4:** State Equations: zero-state, zero-input and total responses in RLC networks; Network Functions: poles, zeros and their properties;

**Module 5:** Resonant Circuits; Two-Port Networks: impedance, admittance and hybrid parameters; Magnetic Circuits and Transformers.

**Textbooks:**

1. E. Fitzgerald, D. E. Higginbotham, A. Grabel; Basic Electrical Engineering; Fifth Edition, McGraw-Hill, 2009.
2. A. Desoer, E. S. Kuh; Basic Circuit Theory; Tata McGraw-Hill, 2009.
3. M. E. Van Valkenburg; Network Analysis; Third Edition, PHI Learning, 1980.

**Course Code:** EE 1105  
**Course Name:** Electronics  
**Credits:** 2 (2-1-2)  
**Course Position:** Semester 1

**Course Content:**

**Module 1:** Signals and signal processing: Analog, Discrete and Digital signals and their characterization; Electronic circuits for implementing mathematical operations; Need for active devices; Transistors: characteristic, load line and biasing techniques; Small signal transistor amplifiers and its incremental equivalent circuit;

**Module 2:** Differential amplifier: its characteristics and operation; Mathematical operations performed using Operational Amplifier (OPAMP); CMRR, slew rate and gain-bandwidth product; OPAMP based amplifiers and applications: spectral analysis and active filters;

**Module 3:** Feedback: various topologies of feedback network; Nonlinear applications of OPAMP, sinusoidal oscillators and negative resistance circuits;

**Module 4:** Power amplifiers: Class A, AB, B, C, D: their operations and efficiency; Rectifier circuits, voltage regulators and power supplies;

**Module 5:** Introduction to digital circuits: ADC/DAC and their implementations; Digital Logic Gates, representing boolean functions: expression, truth table, circuit; boolean minimization using Karnaugh maps; Adders; Comparators; Multiplexers; Encoders / Decoders; Latches – SR Latch, D Latch; Flip Flops – D, JK, T Flip-flops; Synthesizing sequential state machines.

**Textbooks:**

1. A. Malvino, D. J. Bates; Electronics Principles; Seventh Edition, McGraw-Hill, 2007.
2. R. A. Gayakwad; Op-amps and Linear Integrated Circuits; Fourth Edition, Prentice Hall, 2000.
3. M. M. Mano; Digital Logic and Computer Design; First Edition, Pearson Education, 2004.

**Course Name:** Earth and Environmental Sciences  
**Course Code:** CE 1101  
**Credits:** 2 (2-0-0)  
**Course Position:** Semester 1

**Course Content:**

**Module 1:** The earth system: Earth in the solar system. Atmosphere and oceans: Origin and evolution; Atmosphere-ocean interaction; Air pollution, Greenhouse effect, Ozone layer; Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their Interactions.

**Module 2:** Environment and Environmental Studies: Definition and Components of Environment, Relationship between the different components of Environment, Man and Environment relationship, Impact of technology on Environment, Environmental Degradation, Multidisciplinary nature of the Environment studies, its scope and importance in the present day Education System

**Module 3:** Ecology and Ecosystems: Introduction: Ecology- Objectives and Classification, Concept of an ecosystem- structure and functions of ecosystem, Components of ecosystem- Producers, Consumers, Decomposers. Bio-Geo- Chemical Cycles- Hydrologic Cycle, Ocean currents and waves. Lithosphere, Hydrosphere, Cryosphere and atmosphere and their Interactions, Carbon cycle, Energy Flow in Ecosystem, Food Chains, Food webs, Ecological Pyramids Major Ecosystems: Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem, Estuarine Ecosystem.

**Module 4:** Population and Economic Growth: The nature of human population growth, population parameters, industrialisation, urbanisation, sustainable development, sustainable consumption, health and the environmental impacts. Environmental pollution: Types of Environmental Pollution: Water Pollution: Introduction – Water Quality Standards, Sources of Water Pollution: Industrial Agricultural, Municipal; Classification of water pollutants, Effects of water pollutants, Eutrophication Marine pollution- Air Pollution: Composition of air, Structure of atmosphere, Ambient Air Quality Standards, Classification of air pollutants, Sources of common air pollutants like PM, SO<sub>2</sub>, NO<sub>x</sub>, Natural & Anthropogenic Sources, Effects of common air pollutants Land Pollution: Land uses Land degradation: causes, effects and control, soil erosion. Noise Pollution: Introduction, Sound and Noise, Noise measurements, Causes and Effects Thermal Pollution: Causes and effects, Role of individual in the prevention of pollution

**Module 5:** 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 – role of non-governmental organization. Environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, and ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation – consumerism and waste products. Environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.



**Textbooks:**

1. The Good Earth: Introduction to Earth Science. 2<sup>nd</sup> Edition, McConnell, Steer, Knight, Owens & Park (2010), McGraw-Hill, New York, USA.
2. Geology for Geotechnical Engineers, J.C. Harvey, Cambridge University Press
3. Basics of Environmental Studies, Varandani, LAP -Lambert Academic Publishing , Germany.
4. Basics of Environmental Studies U K Khare, 2011 ,Tata McGraw Hill
5. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
6. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India Pvt Ltd, New Delhi, 2007.
7. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) Pvt, Ltd, Hyderabad, 2015.
8. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.
9. The Good Earth: Introduction to Earth Science. 2<sup>nd</sup> Edition, McConnell, Steer, Knight, Owens & Park (2010), McGraw-Hill, New York, USA.

**Course Code:** ME 1101  
**Course Name:** Engineering Drawing  
**Credits:** 1.5 (0-0-3)  
**Course Position:** Semester 1

**Course Contents:**

**Module 1:** General principles, projection systems and multiview drawing: Sizes of drawing sheets, layouts, scales, lines, and lettering. The multiview projection method: orthographic representations including first and third angle projections. Projection symbols.

**Module 2:** Pictorial drawing: Isometric projection. Isometric drawing / isometric view. Oblique projections: cavalier view, and cabinet view.

**Module 3:** Sectioning: The cutting plane and its line type. The viewing direction. Naming the sectional view. Hatching of internal surfaces contacting the cutting plane. Convention for hidden features below the cutting plane. Half sections. Offset sections. Revolved sections, removed sections, local sections, and successive sections. Conventions on not hatching shafts, ribs, keys, fasteners, and spokes of wheels.

**Module 4:** Computer aided drafting: Practical training on the basics of computer aided drafting using commercial software.

**Module 5:** Dimensioning, tolerancing, annotations, and conventions: Distinction between functional, non-functional, and auxiliary dimensions. Elements of dimensioning: projection lines (extension lines), dimension lines, and leader lines. Types of termination of dimension lines, and origin indication. Placing of dimensions: the aligned and the unidirectional systems. Shape indication, e.g., diameters, radii, etc. Special indications: chords, arcs, and angles. Arrangement of dimensions: Chain dimensioning, and dimensioning from a common feature. Tolerance stack-up in chain dimensioning. Simplified representations of intersections. Representations of square ends. Views of symmetrical parts. Simplified views of repetitive features.

**Textbooks:**

- ❖ Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt. Ltd., Anand, 2012 Reprint

**Course Code:** ME 1102  
**Course Name:** Mechanics  
**Credits:** 3 (2-1-0)  
**Course Position:** Semester 1

**Course Content:**

**Module 1.** Moment of inertia: basic concepts and definitions – Moments of inertia of areas – Parallel-axis theorem and moments of inertia of composite areas.

**Module 2.** Analysis of cables – Cables with concentrated loads - Cables with distributed loads - Parabolic cables.

**Module 3.** Method of virtual work: Introduction - Work of a force - Work of a couple - Principle of virtual work - Applications of the principle of virtual work - Work, potential energy and stability of equilibrium.

**Module 4.** Kinematics and kinetics of particles: Rectilinear motion of particles – Relative motion – Curvilinear motion of particles – Newton’s laws of motion – Newton’s second law of motion and linear momentum – Angular momentum – Orbital motion – Work and energy – Conservation of energy – Impulse and momentum – Impacts – Systems of particles – Analysis of systems of particles using Newton’s second law – Energy and momentum methods for systems of particles.

**Module 5.** Kinematics and kinetics of rigid bodies: Translation and fixed-axis rotation – General plane motion – Instantaneous centre of rotation – Equations of motion for a rigid body – Angular momentum of a rigid body in plane motion – Systems of rigid bodies – Constrained plane motion – Energy methods for rigid bodies – Momentum methods for rigid bodies.

**Textbooks:**

1. F. Beer, E. Johnston, D. Mazurek, P. Cornwell, B. Self, S. Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Hill India, 2017.

**References:**

1. R.C. Hibbeler, Engineering Mechanics: Statics and Dynamics, 11th edition, Pearson, 2009.
2. A.P. Boresi, R.J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1st edition, Cengage Learning, 2008.

**Course Code: HS 1101**

**Course Name: English**  
**Credits: 3 (3-0-0)**  
**Course Position: Semester 1**

**Course Content:**

**Module 1:**

- The Bet- Anton Chekhov
- Seven Ages of Man/ To be or not to be/ Mark Antony's Speech in Julius Caesar- William Shakespeare
- *London*- William Wordsworth; *Ode on a Grecian Urn*- John Keats

Skills: Paragraph Writing: types, structure, features; Topic, supporting and concluding sentences; Definition, Description, Illustration; Concord.

**Module 2:**

- *Ulysses*- Tennyson
- *The Second Coming*- W. B. Yeats
- *Destructors*- Graham Greene

Skills: Expository and Argumentative writing, Fact versus Opinion, Connectors, Noun and Adverbial clauses

**Module 3:**

- 1) A Homemade Education: Malcom X
- 2) I have a Dream: Martin Luther King OR "The Meaning of July Fourth for the Negro" by Frederick Douglas
- 3) The Danger of a Single Story- Chimamanda Adichie

Skills: Essay – Structure, organisation, unity, coherence, cohesion; Developing the thesis; Narrative essay; Active/Passive voice

**Module 4:**

- Wife's Letter- Rabindranath Tagore
- Toba Tek Singh- Sadat Hassan Manto
- Imaginary Homelands- Salman Rushdie

Skills: Close reading and Comprehension; Compare/Contrast and Cause and Effect Essays; Conditionals

## Module 5:

- *Where I live*- Arundhathi Subramaniam
- *Dance Like a Man*- Mahesh Dattani

Skills: Process Analysis Essay; Summarizing; Translation (from Indian language to English)

**Lab Component:** Phonetics & Communication Skills practice cycles (14 weeks):

**I. Introduction to Phonetics:** Phonetics- a branch of Linguistics, International Phonetic Alphabet (IPA), Phonetic Symbols, English as an international language.

**Introduction:** Introduction to effective communication, verbal/non-verbal aspects of communication, components of communication, introducing oneself and others

**II. Sounds of English:** Classification of English phonic sounds into Vowels and Consonants, Description and Characteristic features

**Situational Dialogues:** Role plays, greeting, making requests, seeking permissions, asking for and giving instructions/directions, turn taking, telephone etiquette.

**III. Vowels:** Classification, Description, Articulation, Acoustics, Prosody and Transcription.

**Debates:** Stating points of view, agreeing/disagreeing, asking for and giving information, negotiation and persuasion, making suggestions.

**IV. Consonants:** Classification, Description, Articulation, Acoustics, Prosody and Transcription

**Presentation Skills:** Individual/group presentations, poster presentations, PowerPoint presentations, describing and interpreting non-verbal data, project reports/proposals.

**V. Stress Patterns:** Syllable, Word Stress, Stress Patterns

**Group Discussion:** Team dynamics, techniques for group discussions, intervention, turn taking, summarizing, body language, tone, relevance, fluency and coherence.

**VI. Intonation:** Rising intonation, Falling intonation and Rise- Fall intonation

**Panel Discussion:** Initiating and coordinating discussion, asking for and expressing opinions, providing clarification, coordinating, conducting and participating in meetings.

**VII. Rhythm:** Stressed-time language, Connected speech, Pitch

**Public Speaking:** Structure, organizing thoughts/ideas, effective transitions, summarizing and concluding, body language, tone, JAM sessions.

**Course code:** 1102  
**Course Name:** Media Project  
**Credits:** 1.5 (0-0-3)  
**Course Position:** Semester 1

### **Course Contents**

**Module 1:** Introduction to Image: Properties, elements, technology of imaging. LAB: sketching images, 5 hand drawn images leading to a comic strip, uses of color for the images, INSTAGRAM usage for capturing images.

**Module 2:** Visual Design, Visual and Aural Story telling. LAB: Introduction to Camera, Microphones, Report writing, editing software.

**Module 3:** Introduction to moving images, building up a narrative. LAB: Advance training in camera handling, sound recording, dealing with real life situations, editing to form a narrative with actual footage and writing scripts.

**Module 4:** Production of a 30 to 45 second narrative, using various images set to a pre-recorded audio track in real life situations, dealing with challenges, start of postproduction of documentaries.

**Module 5:** Post Production: Editing of the raw footage to form a structured narrative, dealing with sound and music to enhance the narrative and finalizing the project. Discussing the learning outcomes from the project.

**Course code:** HS 1103  
**Course Name:** French Language and Culture I  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 1

**Objectives:**

To develop basic LSRW skills in French Language, from learning how to pronounce and write French alphabet to picking up phrases and words in written, spoken communication through listening and reading exercises.

**Course Content:**

a) **Topics**

- Alphabet
- Numbers
- Nationality
- Profession
- Country and Cities
- Self-introduction and introducing others

b) **Grammar**

- a) Present tense only with 1<sup>st</sup> group regular and irregular verbs
- b) Negations
- c) Prepositions in front of countries and cities
- d) Likes and dislikes with simple notions

c) **Types of writing**

- a) Very short essay on introduce oneself

**Course Code:** HS 1104  
**Course Name:** Introduction to Entrepreneurship  
**Credits:** 1 (0-0-3)  
**Course Position:** Semester 1

### **Course Description:**

The 21<sup>st</sup> century has dawned with entrepreneurship as major force shaping the global economy. In today's knowledge economy India is emerging as an 'Entrepreneurial nation on a global map. At the heart of this entrepreneurial manifestation is the entrepreneurial mind set. Those who possess the spirit of enterprise have led, and will continue to lead, the economic revolution that has proved repeatedly to raise the standard of living for people everywhere. This course is broadly designed to help you join this revolution to bring about lasting, positive changes in your community, organization and around the world.

This course in a highly experiential workshop mode will help you identify your motivation and entrepreneurial competencies and enable you to practice these competencies with the help of simulation exercises and games.

### **Objectives of the Course**

The primary objective of the course is to identify, inculcate and develop entrepreneurial spirit and competencies in students.

More specifically, the course aims to:

1. Help in understanding and defining innovation & entrepreneurship.
2. Define entrepreneurship as a career and lifestyle option.
3. Develop entrepreneurial competencies and motivation.
4. Help students develop the confidence to venture into challenging career of entrepreneurship.
5. Give them an appreciation of the constraints an entrepreneur faces in the process of launching and managing an enterprise.

### **Learning Outcomes**

**At the end of the course students will be able to:**

1. Define entrepreneurship within the context of society, organizations and individuals.
2. Recognize entrepreneurial attitudes and behaviours within him/her and others.
3. Identify traits/characteristics of an entrepreneur/ intrapreneur as exhibited in behaviour.
4. Analyse elements of the entrepreneurial mind set and discuss the implications for functioning as a successful entrepreneur.



**Course Code:** MA 1202  
**Course Name:** Linear Algebra and Complex Analyses  
**Credits:** 4 (3-1-0)  
**Course Position:** Semester 2

**Course Content:**

**Module 1.** Linear Algebra: Real and complex vector spaces, Linear dependence, Matrix of a vector system, change of coordinates, Linear transformation, addition and composition; kernel and image, rank; one to one and onto maps, matrix of a linear map, Inner product, Cauchy-Schwarz, Norm, triangle inequality. Euclidean spaces, Orthogonal and orthonormal family and basis, Gram-Schmidt orthonormalization and Fourier Series.

**Module 2.** Matrices: Matrix addition and multiplication, singular matrix, determinant, rank, inverse, adjoint, Linear system: abstract study, Gaussian Elimination, Transpose and conjugate matrix; similar matrix, Eigenvalues and eigenvectors of a linear map. Characteristic polynomial of a matrix, diagonalizability, Symmetric and orthogonal matrices, diagonalization of a symmetric matrix.

**Module 3.** Complex Analysis: Complex numbers, Polar form, De Moivre's formula, complex differentiation. Cauchy- Riemann equations. Analytic functions, Elementary functions, Contour and contour integral. Cauchy's theorem and integral formula. Taylor's theorem, zeros of analytic functions. Maximum modulus principle, Laurent series, Cauchy residue theorem, poles and residue.

**Module 4.** Integral Transform: Laplace Transform: Functions of exponential order and examples. Transforms of elementary, transcendental and special functions. Transforms of derivatives and integrals and periodic function, unit step function and impulse function. The inverse transform, Convolution theorem, solution of ordinary differential equations (IVP and BVP). Z-Transform, Fourier Transform.

**Text and Reference Books**

1. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995).
2. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).
3. E. Kreyszig, Advanced engineering mathematics, John Wiley (1999).
4. J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 2008.
5. D.G. Zill, P.D. Shanahan, A first course in complex analysis with applications.
6. J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw Hill, 2008.
7. JL Schiff, The Laplace transform, Springer
8. G. Strang, Linear Algebra and its Applications, Fourth Edition, Books/Cole.

**Course Number:** PH 1201  
**Course Name:** Physics I  
**Credits:** 4 (2-1-2)  
**Course Position:** Semester 2

## Course Content

### Classical mechanics

#### Module 1 (Coordinate systems and Vector Calculus)

Vectors, Algebra of Vectors, Multiplying Vectors, Components of a Vector, Base Vectors, The Position Vector  $r$  and Displacement, Velocity and Acceleration, Formal Solution of Kinematical Equations, More about the Time Derivative of a Vector, Motion in Plane Polar Coordinates.

#### Module 2 (Newton's laws, Types of Forces and Application of Newton's laws)

Newton's Laws and Inertial Systems, Base Units and Physical Standards, Algebra of Dimensions, Applying Newton's Laws, Dynamics Using Polar Coordinates.

Fundamental Forces of Physics, Gravity, Some Phenomenological Forces, A Digression on Differential Equations, Viscosity, Hooke's Law and Simple Harmonic Motion.

Dynamics of a System of Particles, Center of Mass Coordinates, Conservation of Momentum, Impulse and a Restatement of the Momentum Relation, Momentum and the Flow of Mass, Rocket Motion.

#### Module 3 (Work-energy theorems, conservative forces and angular momentum)

Integrating Equations of Motion in One Dimension, Work and Energy, Conservation of Mechanical Energy, Potential Energy, What Potential Energy Tells Us about Force, Energy Diagrams, Non-conservative Forces, Conservation Laws and World Energy Usage.

Small Oscillations in a Bound System, Stability Normal Modes Collisions and Conservation Laws. Angular Momentum of a Particle, Fixed Axis Rotation, Torque and Angular Momentum, Dynamics of Fixed Axis Rotation, Motion Involving Translation and Rotation, Work–Energy Theorem and Rotational Motion, Vector Nature of Angular Velocity and Angular Momentum, Gyroscope.

#### Module 4 (Central forces, gravitation, Kepler's law dynamics of rigid bodies (2D))

Central Force Motion as a One-body Problem, Universal Features of Central Force Motion, Energy Equation and Energy Diagrams, Planetary Motion, Some Concluding Comments on Planetary motion, Integrating the Orbit Integral and Properties of the Ellipse.

#### Module 5 (Harmonic oscillators and waves)

Simple Harmonic Motion: Review, Damped Harmonic Oscillator, Driven Harmonic Oscillator, Transient Behavior, Response in Time and Response in Frequency.

Types of waves, Energy and Power of a Wave travelling along String, Wave Equation, Standing waves and Resonance, Travelling Sound waves, Doppler Effect and Supersonic speed and Shock waves.

### Textbooks:

1. An Introduction to Mechanics by Daniel Kleppner and Robert Kolenkow, Cambridge University Press
2. Berkeley Physics Mechanics Vol. 1 by Charles Kittel, Walter D. Knight, Malvin A. Ruderman
3. Physics for Scientists and Engineers, Fishbane, Gasiorowicz, Thornton, Prentice Hall

## **LABORATORY WORK**

### **Objectives:**

The objective of the course is to let the students understand practically what basic laws and their effects are. They will practice mechanical, thermodynamical, optical and electromagnetical experiments and will be able to develop their intuitive understanding of natural effects. In parallel with the theoretical lectures they will face reality and will be in position to make links with its mathematical expressions.

### **Course Content:**

#### **Mechanics (Semester 1)**

- ❖ Maxwell's wheel: free fall, inertia momentum
- ❖ Pendulum: Eigen frequency of an oscillator, momentum, gravity force
- ❖ Collisions of projectiles: 1D motion, elastic and inelastic collisions
- ❖ Vibrating string: standing waves, eigenmodes, influence of boundary conditions
- ❖ Acoustic Doppler effect: analogic mixing of electric signal to detect a change in the frequency
- ❖ Kundt's tube: to determine velocity of sound in air
- ❖ Lee's disk method: to measure thermal conductivity of various insulators
- ❖ Force and momentum: to validate Newton's laws of motion

**Course Code:** CH 1202  
**Course Name:** Chemistry – II (Organic, Polymer, and Applied Chemistry)  
**Credits:** 3 (2-0-2)  
**Course Position:** Semester 2

**Module – 1:** Chemical Kinetics: Rate Law and order of reactions; extent of reaction, Determination of reaction rates; Effect of temperature; Theories of chemical kinetics; Introduction to Catalysis (air pollution, catalytic converter).

**Module – 2:** Organic chemistry: Structural isomers and stereoisomers, optical activity, absolute configurations and conformational analysis. Introduction to organic reactions involving substitution, addition, elimination, oxidation and reduction. Reaction mechanisms and reactive intermediates. Chromatographic techniques. Synthesis of some commonly used drug molecules.

**Module – 3:** Polymers: Synthetic and natural polymers. Methods of polymerization, Molecular weight and determination, Glass transition temperature. Structure-property correlations. Examples of some specific polymers.

**Module – 4:** Electrochemistry: Electrochemical Cell, Half-cell reactions and electrodes, Standard electrode potential, Electrochemical Series, Nernst equation. Electrochemistry of corrosion and preventive methods. Batteries: different types of batteries and applications.

**Module – 5:** Nanoscience: Basics of nanomaterials, Synthesis- Bottom-up and Top-down approach, Characterization- Electron microscopy techniques, Applications- electronics, medicinal.

#### **List of laboratory experiments:**

1. Determination of total hardness of water by complexometric titration.
2. Determination of surface tension of a liquid by drop count method and the effect of additives.
3. Study of kinetics of hydrolysis of ester.
4. Determination of equilibrium constant of  $KI + I_2 = KI_3$  by solubility method.
5. Simultaneous determination of concentrations of strong and weak acid in a mixture using conductometric titrations.
6. Preparation of phosphate/citrate buffers and evaluating their pH resistance.
7. Estimation of amount of  $Cu^{2+}$  or  $Ni^{2+}$  present in a solution using UV-Visible spectrophotometer and Beer-Lambert's law.
8. Synthesis of silver nanoparticles by reduction of  $AgNO_3$  and the evaluation of the optical properties by UV-Vis spectrophotometry.
9. Synthesis of benzilic acid from benzil using solid phase synthesis (Green chemistry).

10. Synthesis and FT-IR spectroscopic characterization of dibenzalacetone.
11. Determination of critical micellar concentration (CMC) of a surfactant.
12. Synthesis of an organometallic complex and spectroscopic characterization.
13. Synthesis of a polymer such as Bakelite.
14. Paper chromatography and separation of natural pigments.
15. Synthesis of Aspirin.

**Textbooks:**

1. Atkin's Physical Chemistry; 10th edition; Peter Atkins and Julio De Paula; ISBN 978-0-19-954337-3
2. Organic Chemistry; Jonathan Clayden, Nick Greeves and Stuart Warren; ISBN: 978-0-19-927029-3

**Course Code:** CS 1201  
**Course Name:** Introduction to Computer Science  
**Credits:** 4 (2-1-2)  
**Course Position:** Semester 2

## **Course Contents**

**Module 1:** Representation of data: Number systems; Conversion from one base to the other; Binary number system; Representation of Binary numbers using Physical devices; Basic logic gates and binary logic; Short, Int, Long types; Integer arithmetic using logic gates; Float point representation; Float, Double, long Double data types; Characters - ascii codes; Boolean variables; IEEE standards and history.

**Module 2:** Von Neumann architecture of modern computing system; Low level languages vs High level Languages; Compilation and byte code; Introduction to C programming language; Variables, type declaration and operations. Control structures and manipulation of data: Conditional Constructs if, ifelse, while, for, do-while, switch, break, continue. Functions: Implementation of functions in C, recursion, Iteration vs recursion.

**Module 3:** Pointers and Arrays: The pointer datatype; Declaring pointer variables; Passing a reference using pointers; Null pointers. Arrays; Declaring and using arrays; Arrays as parameters; Strings in C; Relation between arrays and pointers; N-dimensional arrays; What is an algorithm?; Algorithms: Sorting examples - Insertion sort, Bubble sort, mergesort. Searching examples - linear search, Binary search. Structures; Dynamic Memory Allocation; Malloc - Free functions; Dynamically Sized arrays; Implementation of Linked lists. File handling: Reading and writing files; Writing header files; Make and Installation Packages.

**Module 4:** Introduction to interpreted languages; Introduction to Python3; Dynamic typing; inbuilt data types - Strings, Lists, Tuples, Sets, Dictionaries, and methods. Subscriptables and Iterables; the while and for loops; Functions – Polymorphism in Python functions; Introduction to Python classes; Brief introduction to Object Oriented Programming.

**Module 5:** Standard modules in Python for scientific computing and plotting; Handling files; Implementation of various algorithms (search, sort etc) in Python; Speed comparison with C; Integration of C programs into Python scripts.

## **Textbooks:**

1. Introduction to Computing Systems: From Bits & Gates to C & Beyond; Yale Patt & Sanjay Patel
2. C: How to Program; Paul Deitel, Harvey Deitel
3. Dive into Python; Mark Pilgrim
4. Beginning Python: Novice to Professional; Magnus Lie Heitland
5. Python Algorithms; Magnus Lie Heitland

**Course Code:** ME 1203  
**Course Name:** Workshop Practice  
**Credits:** 1 (0-0-2)  
**Course Position:** Semester 1

**List of Typical Experiments:**

- Introduction to Workshop: Overview and Safety Practices (1 week)
- Hand Tools & Machining Demonstration (1 week)
- Benchwork and Fitting (2 weeks)
- Woodwork and Carpentry (2 weeks)
- Welding Demonstration (1 week)
- Introduction to Machine Tools (1 week)
- Lathe and Milling: Basic Operations (2 weeks)

**Textbooks:**

- Workshop Practice by B. L. Juneja, 2016, Cengage Learning.

**Course Code:** ME 1204  
**Course Name:** Thermodynamics  
**Credits:** 3 (2-1-0)  
**Course position:** Semester 2

**Course Content:**

**Module 1: Introductory Concepts and Definitions**

System and Surroundings, Macroscopic and Microscopic approaches, Intensive and Extensive Properties, Path and Process, Thermodynamic Equilibrium, Zeroth Law.

**Module 2: First Law of Thermodynamics**

Closed and Open Systems, Energy, Heat and Work, First law for closed system and flow process, Applications of First law.

**Module 3: Properties of Pure Substances**

Properties of gases Pure substance, Liquid, Solid, and Vapour Phase Properties, Triple Point, Critical Point, Dryness Fraction, use of Vapour Tables, Mollier Chart.

**Module 4: Second Law of Thermodynamics**

Clausius and Kelvin-Planck Statements, Heat Engines and Heat Pumps, Reversibility, Carnot Efficiency, Entropy, Availability and Irreversibility

**Module 5: Basics of Energy Conversion Cycles**

Carnot Cycle, Air-Standard Cycles, Mean Effective Pressure, Vapour Power Cycles, Refrigeration Cycle, Vapour Compression Cycle

**Textbooks:**

1. P.K. Nag, "Engineering Thermodynamics", McGraw Hill, New Delhi
2. Van Wylen, "Engineering Thermodynamics", Wiley
3. Cengel, "Thermodynamics - An Engineering Approach", Tata McGraw Hill, New Delhi

Moran and Shapiro, Principles of Engineering Thermodynamics", John Wiley & Sons



**Course Code:** CE 1202  
**Course Name:** Building Materials  
**Credits:** 2 (2-0-0)  
**Course Position:** Semester 2

**Course Content:**

**Module 1:** Sources of Aggregates & Properties: Physical and Mechanical properties of construction materials, commonly used types of stones, Tests for stones, road aggregates and concrete aggregates, properties of sand, BIS specification for testing of aggregates, Bricks, Properties and testing methods for Bricks.

**Module 2:** Modern Construction Materials: Structural Steel and Aluminium, Roofing Material, Physical descriptions of asbestos sheets, GI sheets, tubes and light weight roofing materials, Timber, Types, Seasoning and various products, Modern materials, Neoprene, thermocole, decorative panels and laminates, architectural glass and ceramics, ferrocement, PVC, polymer base materials, fibre reinforced plastics.

**Module 3:** Flooring & Roofing Materials: Principles of construction, Bonding, Reinforced brick work, Stone masonry, Hollow block masonry, Pointing, Plastering, DPC Floor and Roof Construction: Floors, General Principles, Types of floors, Floor coverings, Types of roofs.

**Module 4:** Prefabricated buildings: Sound insulations – Ventilations–Fire resisting construction–Prefabricated panels and structures–production, transportation and erection of structures.

**Module 5:** Sustainable materials: Bamboo, Fly ash brick, Specifications of green building council.

**Textbooks:**

- S.C.Rangwala, K.S. Rangwala, P.S. Rangwala. Engineering Materials (Materials Science), Charotar Publishing House (2011)
- Fundamental building materials by Ken Ward-Harvey.
- Building Construction by Arora.S.P & Bindra.S.P

**Course Code:** HS 1201  
**Course Name:** Entrepreneurship practice  
**Credits:** 1 (0-0-2)  
**Course position:** Semester 2

### **Course Description:**

This course is all about learning by doing. Students either in teams or individually create, develop, launch, and manage a new venture partly funded by the College. An entrepreneur's resource base is initially determined by who they are, what they know, what they currently have, and whom they know. Cash is not necessarily the most needed asset to start something new. During the semester, students are introduced to the 5 principles of effectuation and are challenged to apply these principles in real life. The challenge requires students to generate as much profit as they can within two weeks during the summer break. The challenge is a great lesson in bootstrapping and starting something with seemingly nothing. However, students quickly learn that cash is not their greatest asset and starting with what they have rather than what they need increases their probability of success.

### **Objective of the Course**

The primary objective of the course is to enable students to discover their resourcefulness and unleash their creativity with minimal direction.

More specifically, the course aims to:

1. Help in practicing entrepreneurial competencies.
2. Acquire courage to face uncertainties with a minimal risk.
3. Develop bootstrapping skills.
4. Help students develop the confidence to venture into challenging career of entrepreneurship.
5. Encourage nascent entrepreneurs to "think cash last."

### **Learning Outcomes**

**At the end of the course students will be able to:**

1. Demonstrate that value can be generated with very little.
2. Apply an entrepreneurial mindset to resource acquisition.
3. Practice entrepreneurial competencies

**Course Code:** HS 1202  
**Course Name:** Professional Ethics  
**Credits:** 1 (0-1-0)  
**Course Position:** Semester 2

**Course Content:**

**Module 1:** Why be moral? Introduction to ethical theories. Is and Ought. What is and what ought to be? Fact-value distinction

**Module 2:** End and Means. Classical dilemma, Debates and theories. Gandhian Ethics. The concept of shreyas and preyas.

**Module 3:** Justice. Classical theories of justice. Crime and punishment. Malpractices.

**Module 3:** Rights, Duties and Responsibilities. Natural rights, Fundamental rights and Human dignity. Freedom and autonomy. Duties and responsibilities. Legal rights. Patents and intellectual rights

**Module 4:** Good Life. Happiness. Harmony. Care and Compassion

**Module 5:** Case studies of professionals, institutions and organizations

**Textbooks / References:**

1. Handouts of classical texts by various philosophers will be provided to students. (Socrates, Kant, Hume, Locke, Mills, Bentham, Rawls, Gandhi, etc.)
2. Practical Ethics by Peter Singer
3. Applied Ethics by Peter Singer
4. What We Owe Each Other by T. M Scanlon Fundamental Ethics – for Scientists and Engineers by Edmund Seebauer and Robert Barry

**Course Code:** HS 1203  
**Course Name:** French Language and Culture II  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 2

**Objectives:**

To develop basic LSRW skills in French Language, from learning how to pronounce and write French alphabet to picking up phrases and words in written, spoken communication through listening and reading exercises.

**Contents:**

- **Topics**
  - Family
  - Hobbies and pastimes
  - Leisure activities
  - Describing habit and routines
  - Weather description
  
- **Grammar**
  - Possessive adjective
  - Near future
  - Past tense
  - Negation
  - Spatial location : - venir de / aller à + ville ou pays
  - Adverb of time: now, this week, tomorrow, last month etc...
  - Fixed preposition with some verbs( aller, venir, faire, jouer)
  
- **Types of writing**
  - Post card writing
  - Family tree
  - Likes and dislikes with advanced notions

**Course Code:** MA 2103  
**Course Name:** Probability and Statistics  
**Credits:** 4 (3-1-0)  
**Course Position:** Semester 3

**Course Content:**

**Module 1:** Probability and Random Variables Axiomatic definition of probability, Sample Space, Events, Conditional Probability, Independence of Events, Theorem of Total Probability, Baye's Theorem, Discrete and Continuous Random Variables, Probability Mass Function, Probability Density Function, Cumulative Distribution Function, Moments, Mathematical Expectation, Variance, Standard Deviation, Moment Generating Function.

**Module 2:** Discrete and Continuous Distributions Binomial Distribution, Poisson Distribution, Uniform Distribution, Exponential Distribution, Normal (Gaussian) Distribution, Markov's Inequality, Chebyshev's Inequality.

**Module 3:** Random Vectors: Joint Probability Distribution of Functions of Random Variables, Independence of Random Variables, Covariance, Variance, Expectation, Correlation, Multinomial Distribution, Transformations of Random Variables, The Law of Large Numbers, The Central Limit Theorem.

**Module 4:** Random Processes: Continuous and Discrete Random Processes, Autocorrelation Function, Auto covariance Function, Correlation Coefficient, The Bernoulli Process, The Poisson Process, The Wiener Process, The Markov Chain, Stationarity: Strict-Sense Stationary (SSS) and Wide-Sense Stationary (WSS) Processes.

**Module 5:** Statistics: Descriptive Statistics: Sample Mean, Sample Variance, Sample Standard Deviation and Sample Correlation Coefficient; Confidence Intervals, Parameter Estimation: Unbiasedness, Consistency, Point Estimator, Maximum Likelihood Estimators.

**Textbooks:**

1. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, Fifth Edition 2016.
2. Sheldon M. Ross, Introduction to Probability Models: 11th Edition, Academic
3. Press Elsevier, 2015. □ Jean Jacod and Philip Protter, Probability Essentials, Springer, 2004.
4. Hogg, Tanis and Rao, Probability and Statistical Inference: 7th Edition, Pearson, 2006.
5. Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, Pearson, 2008.

**Course No:** PH 2102  
**Course Name:** Physics II  
**Credits:** 5 (3-1-2)  
**Course Position:** Semester 3

### **Objectives**

The objective of this course is to introduce and present the basics of Fields and Waves in the context of Electromagnetism and Optics

### **Course Contents**

#### **Electrostatics**

Physical definitions of Gradient, divergence and curl operators, curvilinear coordinates, Dirac Delta function, Theory of vector fields, Coulomb's law and principle of superposition, Gauss's law and its applications, Electric potential and electrostatic energy, Poisson's and Laplace's equations with simple examples, uniqueness theorem, boundary value problems, Properties of conductors, Multipole expansion, Electric fields in matter, Dielectrics and polarization

#### **Magnetostatics**

Biot & Savart's law, Amperes law, Divergence and curl of magnetic field, Vector potential, Vector potential, Magnetic field in matter, Bound currents, Field H, Classification of magnetic materials, Faraday's law in integral and differential forms, Motional EMF, Displacement current

#### **Electromagnetism**

Maxwell's equations, Electromagnetic waves, wave equation, e.m. waves in vacuum and media, refractive index, Energy and momentum of e.m.w., Poynting vector, Polarization of e.m. waves, Reflection and refraction, skin depth, standing electromagnetic waves, Electric dipole radiation, Waveguides with rectangular metallic boundaries, TE, TM and TEM mode.

#### **Optics**

Some discussions on geometrical optics, Wave optics: Interference between two coherent waves, Fresnel and Fraunhofer diffraction, Diffraction grating, polarization, Fiber Optics

#### **Labs**

1. Geometrical optics with lenses
2. Newton's rings
3. Single-and double-slit diffraction
4. Spectrometry of a glass prism
5. Polarization study with half and quarter wave plates
6. Helmholtz coils
7. Faraday's law
8. B-H loop
9. Hall effect

**Course Code:** CS 2102  
**Course Name:** Data Structures  
**Credits:** 5 (2-2-2)  
**Course Position:** Semester 3

### Course Contents

**Module 1:** Introduction to Data Structures: Single and Multi-dimensional Arrays, Sparse Matrices (Array and Linked Representation) . Introduction to Algorithms: Algorithm Development, Complexity analysis, Recursion. Growth of Functions & Asymptotic Notations. Rates of Growth:  $O(n)$ ,  $\Omega(n)$ ,  $\Theta(n)$ ,  $o(n)$ ,  $\omega(n)$ , Run-Time Complexity, Space Complexity, NP-Completeness (Time Permitting). Complexity Class - P, NP, NP Complete, NP Hard, Is P=NP? and Reductions.

**Module 2:** Linear Data Structures- Stacks: Operations and Applications, Implementing single / multiple stack/s in an Array; Prefix, Infix and Postfix expressions, Applications of stack; Limitations of Array representation of stack. Links Lists: Operation – Creations, insertion, Deletion, Circular Lists, Doubly Linked List. (Approaches, Implementation Issues, Complexity & Efficiency), Amortized Analysis.

**Module 3:** Array and Linked representation of Queue, De-queue, Priority Queues, Circular Queues: Operations and Applications  
Sorting Algorithms & Searching: Bubble sort, Quick Sort, Insertion Sort, Merge Sort, Selection sort, Heap Sort, Radix sort and Bucket sort. Lower bound for comparison based sorting algorithms. Linear Search, Binary Search.

**Module 4:** Introduction to Hashing, Deleting from Hash Table, Efficiency of Rehash Methods, Hash Table Reordering, Resolving collision by Open Addressing, Coalesced Hashing, Separate Chaining, Dynamic and Extendible Hashing, Choosing a Hash Function, Perfect Hashing Function

Introduction to Tree as a data structure; Binary Trees (Insertion, Deletion , Recursive and Iterative Traversals on Binary Search Trees); Threaded Binary Trees (Insertion, Deletion, Traversals); Height-Balanced Trees (Various operations on AVL Trees).

**Module 5:** Graphs I: Representation and Traversal (Preorder, Inorder, Postorder ) - • Representation: Matrix, Adjacency list; Traversal: Depth First Search, Breadth First Search; Graphs II: Basic Algorithms - Minimum Spanning Tree, Shortest Path, All pairs Shortest Path, Transitive Closure

### Textbooks:

1. Aaron M. Tenenbaum, Moshe J. Augenstein, YediyahLangsam, "Data Structures Using C and C++;, Second edition, PHI, 2009.
2. Micheal T. Goodrich and Roberto Tamassia: Algorithm Design: Foundations, Analysis and Internet examples (John Wiley & Sons, Inc., 2002)
3. Cormen T.H., Leiserson, C.E., Rivest, R.L., and C. Stein. Introduction to Algorithms, MIT Press, Second Edition (Indian reprint: Prentice-Hall).
4. Sanjoy Das Gupta, Christos Papadimitriou, Umesh Vazirani, Algorithms; Tata McGraw-Hill Publishers
5. Alfred V. Aho, John E. Hopcroft, Jeffery D.Ulman. Data Structures and Algorithms
6. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran. Computer Algorithms

7. Robert L. Kruse, "Data Structures and Program Design in C++", Pearson, 1999.



**Course Code:** CE 2103  
**Course Name:** Mechanics of Materials  
**Credits:** 4 (3-1-0)  
**Course Position:** Semester 3

**Course Content:**

**Module 1:**

Stress-Strain behaviour for uniaxial loading, Generalized Hooke's law, Elastic constants for isotropic materials, Notion of equilibrium, Free body diagrams, Deformation of axial members, Statically determinate and indeterminate problems, Truss structures – Stiffness methods.

**Module 2:**

Definition of stress, Different states of stress – uniaxial, biaxial, plane stress, Transformation of plane stress, Principal stresses and maximum shear stress, Mohr's circle.  
Definition of strain – shear and normal strains, Transformation of plane strain, Principal strains.

**Module 3:**

Bending moment and shear: Relation between transverse loads, shear and bending moments, Shear and bending moment diagrams  
Bending stresses: Beam bending equation and bending stresses in beams  
Shear stresses: Derivation of shear stress, Shear stresses in beams,

**Module 4:**

Torsion: Torsional moment diagrams, Torsion formula for circular cross-sections, Maximum normal and shear stresses, Angle of twist, Power transmission through shafts.

**Module 5:**

Elastic stability: Notion of stability of equilibrium, Euler buckling.  
Analysis of Truss: Method of Joints, Method of sections, Graphical methods

**Textbooks:**

1. An Introduction to the Mechanics of Solids, Crandall S.H, Dahl N.C, McGraw-Hill.
2. Strength of Materials Vol. I by S P Timonshenko.
3. Engineering Mechanics of Solids by Egor P Popov

**Course Code:** CE 2104  
**Course Name:** Building Drawing  
**Credits:** 2 (0-0-4)  
**Course position:** Semester 3

## **Course Content**

### **Module 1:**

Introduction: Types of drawing with appropriate scale & uses index map, key plan, village map, site plan, layout plan. Types of Projection adopted in Building Drawing, Scales for various types of Drawings Working drawing, large scale drawing enlarges scale drawing. Symbols, Conventions and Abbreviations for - Electrical fittings, water supply, sanitary fittings, material for construction etc.

### **Introduction to National Building Code (SP7:2016)**

### **Module 2:**

Building Regulations Byelaws and Principles of Planning: building bye laws of local body for residential building (show local authority publication) -plot area, built up area, carpet area, FSI, size of rooms, margins, heights, passages, ventilation, circulation and others. Principles of planning for residential building in detail such as - Room dimension, area, heights, privacy, roominess factor, orientation, grouping, drainage, aspect, prospect, drainage, economy.

### **Module 3:**

Planning of a Residential Building: Concept plan and drawing of residential single and two storied buildings. Concept plan of public buildings such as hospital, school, shopping center, office building and industrial unit. Given situation & Plot area, preparation of detailed drawing of a single storied and double storied residential building with detail of Line plan, Detailed Plan, Ground floor Plan, First floor plan, Elevation and Sections

### **Module 4:**

Perspective Drawing and Modeling: Introduction of perspective view and other related terms. Perspective view of single room residential building and simple public buildings. Elements of perspective drawing. Model preparation of simple buildings

### **Module 5:**

Constructional Detail Drawings of a Building: Drawings of Parts of buildings such as staircases, chajjas , projections, columns , pier, slabs, footings etc. Provisions in drawings for building services such as air conditioning, plumbing, water supply and firefighting, elevators, lifts and escalators etc. Electrification plan and drawings; Show building service like water supply, sanitary, electrification on line plan.

### **Practical Exercises:**

1. Interpretation of building drawings approved under local authority.
2. Draw symbols, conventions and Abbreviations in sketch book
3. Draw detail plan on drawing sheet - 1 plan, elevation and section of existing building (actual Measurement Drawing).
4. Draw detail of foundation plan of one room building /two room building in sketch book
5. Draw working drawings sheet -2 for single storied residential building (bungalow)on 250sq.m plot with scale and show following detail: GF & FF plan with elevation, section and opening schedule
6. Prepare concept plan of any one other type of building considering local bye laws: high school building, Shopping centre, Hospital and Industrial Building in sketch book.

7. Develop perspective view of single room residential building with verandah & steps by any methods.
8. Visit a residential building and observe the existing building service and Draw line plan for above services in sketch book.
9. Prepare a model of a simple building using card board.

**Text Book:**

V. B. Sikka, *Civil engineering drawing* B. D. Kataria Sons , Ludhiana

**Codes:** SP7: 2016, National Building Code

**Reference Books:**

1. Gurcharan singh, Subash chander, *Civil Engineering Drawing*, Standard Publishers Distributors, Delhi
2. S. Malek G. S. Meo, *Civil Engineering Drawing*, New Asian Delhi.

**List of Software/Learning Websites:**

AutoCAD, Zwcad, civil Architect, draw plus X5

[www.Autodesk.com](http://www.Autodesk.com),

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

[www.learn-to-draw.com](http://www.learn-to-draw.com)

**Course Code:** CE 2105  
**Course Name:** Geology Lab  
**Credits:** 1 (0-0-2)  
**Course Position:** Semester 3

**Course Content:**

1. A brief introduction to rock formations (folds, faults and fissures) and origin of igneous, sedimentary and metamorphic rocks.
2. Aim, Objectives, Theory and Procedures of Experiment 1 to 5
3. Geological cross section and study of geological maps (5 samples)
4. Study of physical properties and Identification of minerals.
5. Megascopic description and identification of Igneous rocks.
6. Megascopic description and identification of Sedimentary rocks.
7. Megascopic description and identification of Metamorphic rocks.
8. Dip and Strike Problems: To measure dip, dip direction and strike of given formations

**Text Book:**

1. Subinoy Gangopadhyay, *Engineering Geology*, Oxford University Press.

**Course Code:** HS 2101  
**Course Name:** Lean Start-up  
**Credits:** 1 (0-0-3)  
**Course Position:** Semester 3

**Course Description:**

The course aims at giving you practical experience in starting a technology-based start-up or leading a new product development initiative in an established corporation. The course is based on the principles of lean-startup developed by Eric Ries and Steve Blank. **Lean Startup** is a new, field-tested philosophy that provides you with a toolset to minimize failure and increase your chances of success. Through practical experience, student-driven seminars, understanding of business model components in the start-up process, as well as ability to analyze and validate an idea or invention is mainly achieved through customer-based development and experimentation with minimum viable products.

**Objectives of the Course**

The primary objective of the course is to enable students to learn how to rapidly develop and test ideas by gathering massive amounts of customer and marketplace feedback.

More specifically, the course aims to:

1. Learn the basic principles of lean start-up
2. Build products that meet customer needs
3. The easiest and fastest ways to build minimum viable products which could be launched quickly.
4. Tactics for experimentation with landing pages, A/B tests, MVPs on real customers

**Learning Outcomes**

**At the end of the course students will be able to:**

1. Describe and explain the lean startup process
2. Develop hypotheses based on the business model canvas to test the viability of an idea or invention
3. Validate different parts of the idea using user, customer, and partner feedback.
4. Develop a minimum viable product for effective customer-based development
5. Interview potential users, customers and partners

**Course Code:** HS 2102  
**Course Name:** French Language and Culture III\*/ Other Foreign Language.  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 3

**Objectives:**

The aim of this course is to understand very short, simple information in the spoken and written language and to express oneself simply and briefly in speech and in writing for practical purposes in everyday situations requiring a direct exchange of information. It is expected that productive skills will be limited and fragmented and that language will be mostly or completely formulaic at this level; receptive skills will be more developed than productive skills.

**Course Content:**

**General themes**

- People: Family, Physical description
- Places: Cafe, Restaurant, Shops, Bank, Post office, Hotel, Road
- Hobbies: Sports, Going out, Shows, Holiday trips
- Daily Life: Work, Shopping,
- Daily activities

**Grammar topics**

- Pronominal verbs: verbes reflexifs and pronominal verbs  
Past Simple - events in the past
- Past participles  
Imperfect tense - descriptions in the past (it was, there was)  
Imperative - Affirmative and Negative - for instructions and commands
- Near Future Tense  
Future simple tense
- Conditional tense



**Course Code:** HS 1203  
**Course Name:** Economics  
**Credits:** 1.5 (1.5-0-0)  
**Course Position:** Semester 3

**Course Description:**

This course introduces students to basic economic concepts essential for understanding contemporary issues in the Indian economy. The main topics that are covered include the major definitions followed by the theory of demand and supply. Further, the module will sensitize the students to the features of the Indian economy. It will further enlighten the students to applied areas of economics like the attention economy and the creative economy.

In this module, you will learn the challenges of economic development from the perspective of an emerging economy with a focus on poverty, human development, and sustainable development goals. The module will conclude with a discussion on current policies and their impact on the economy while analyzing the various reforms implemented by the government.

**Course Objectives:**

- To provide an overview of key economic concepts
- To expose students to the macro-economic theory and lay their understanding of the economy
- To familiarise the students with the Indian economy and make them aware of its features and context within which it has developed.
- To make the students aware of the macroeconomic environment within which enterprises are founded, run, and flourish.
- To provide the students with a conceptual framing to understand and interpret the economy

**Learning Outcomes:** *At the end of a module the learner will be able to:*

- Appreciate the relevance of economics in a changing world while understanding the need for people to make choices
- Analyze the economic context within which companies and individuals operate
- Assess the impact of policies and various reforms on businesses and sectors of the economy
- Evaluate and examine the specific features of economic growth in India and identify opportunities and risks



**Course Code:** MA 2204  
**Course Name:** Numerical Methods  
**Credits:** 4 (3-0-2)  
**Course Position:** Semester 4

**Course Content:**

**Module 1:** Algebraic and Transcendental equations: Computation of floating point numbers and round-off errors and machine representation of numbers. Solutions of non-linear and transcendental equations: order and convergence analysis.

**Module 2:** Interpolation, numerical differentiation and Integration: interpolation; Numerical differentiation, Richardson's extrapolation; Numerical integration: Newton-Cotes formulae, Romberg integration, quadrature formulae.

**Module 3:** System of Algebraic Equations: Norms of vectors and matrices, Linear systems: direct and iterative schemes, ill conditioning, convergence analysis and finding dominant eigenvalues; Numerical schemes for nonlinear systems (Newton's method); Regression.

**Module 4:** Ordinary differential equations: Difference equations; Numerical solution of differential equations: Single step and multi-step methods, order consistency, stability and convergence analysis, stiff equations; Solving two-point boundary value problems by shooting methods and finite difference methods.

**Textbooks:**

1. David Kincaid and Ward Cheney, Numerical Analysis and mathematics of scientific computing, Books/Cole, 1999.
2. Samuel D. Conte and Boor, Elementary Numerical Analysis: Algorithmic Approach, Tata McGraw-Hill, 1980. □ K. Atkinson, Elementary Numerical Analysis, John Wiley, 1978.
3. Richard L Burden and J Douglas Faires, Numerical Analysis, Thomson Books Cole, Seventh edition 2009.

**Course Code:** CE 2206  
**Course Name:** Structural Analysis  
**Credits:** 4 (3-0-2)  
**Course Position:** Semester 4  
**Course Content:**

**Module 1:**

Concept of determinate and indeterminate structures – Moment-curvature relation – Slope and deflection of beams by successive integration – Macaulay's method – Principle of superposition – Moment area method – Conjugate beam method – Deflection and slope of beams with non-uniform flexural rigidity.

**Module 2:**

Introduction to energy methods: Strain energy and complementary energy - Castigliano's theorems and its application to statically determinate beams, rigid-jointed frames and trusses – Principle of virtual work and its application to statically determinate beams, rigid jointed frames and trusses – Maxwell's reciprocal theorem – Principle of minimum potential energy.

**Module 3:**

Moving loads and influence lines: Influence lines for reactions, shear forces and bending moments in simply supported, cantilever, overhanging beams – Maximum effect of moving load for simply supported beams – Absolute maximum shear force and bending moment.

**Module 4:** Indeterminate structures – force methods: Determination of static and kinematic indeterminacy in beams, rigid jointed frames and trusses – Introduction to force method of analysis – Method of consistent displacements and its application to indeterminate beams, rigid-jointed frames and trusses – Effect of temperature and lack of fit in trusses –

**Module 5:** Indeterminate structures- Displacement method and Introduction to Matrix method of analysis: Introduction to displacement method of analysis – Slope deflection method for beams and rigid-jointed frames – Moment distribution method for beams and rigid-jointed plane frames.

**List of Experiments:**

1. Verify the strain in an externally loaded beam with the help of a strain gauge indicator.
2. To study behavior of different types of columns and find Euler's buckling load for each case.

3. Test the two-hinged arch for the horizontal displacement of the roller end for a given system of loading and to compare the same with those obtained analytically.
4. Test the behavior of a portal frame under different end conditions
5. To find the value of flexural rigidity (EI) for a given beam and compare it with theoretical value.
6. To determine the deflection of a pin connected truss analytically & graphically and verify the same experimentally.
7. To verify Clerk Maxwell's reciprocal theorem
8. To verify the moment area theorem regarding the slopes and deflections of the beam.
9. To determine the moment required to produce a given rotation (rotational stiffness) at one end of the beam when the other end is pinned.

**Textbooks:**

1. Hibbeler, R.C., *Structural Analysis*, 6<sup>th</sup> edition, Pearson Education, 2015.
2. Reddy, C.S., *Basic Structural Analysis*, 3<sup>rd</sup> edition, McGraw Hill Education, 2011.
3. Roy, S.K. and Chakrabarty, S., *Fundamentals of Structural Analysis*, Revised edition, S. Chand, 2009.

**References:**

1. Kassimali, A., *Structural Analysis*, 5<sup>th</sup> edition, Cengage Learning, 2015.
2. Leet, K.M., Uang, C.-M. and Gilbert, A.M., *Fundamentals of Structural Analysis*, 3<sup>rd</sup> edition, McGraw Hill Education, 2008.
3. Ghali, A., Neville, A.M. and Brown, T.G., *Structural Analysis: A Unified Classical and Matrix Approach*, 6<sup>th</sup> edition, CRC Press, 2009.
4. Weaver, W. and Gere, J.M., *Matrix Analysis of Framed Structures*, 2<sup>nd</sup> edition, CBS, 2004.



**Course Code:** CE 2207  
**Course Name:** Engineering Surveying  
**Credits:** 3 (2-0-2)  
**Course Position:** Semester 4

**Course Content:**

**Module 1:**

Introduction and Compass surveying. Importance of surveying – Principles - Classifications – Chain and tape measurement – Meridians, Azimuths and Bearings – Compass survey

**Module 2:**

Theodolite and Plane table surveying: Theodolite – Adjustments – Horizontal and Vertical angle measurement – Traversing Plane table surveying- Definitions, uses and advantages, temporary adjustments.

**Module 3:**

Levelling: Differential levelling – Longitudinal and Cross section levelling – Refraction and Curvature correction – Reciprocal levelling

**Module 4:**

Tacheometry and Areas and Volumes: Tacheometry – Constants – Stadia, Tangential and Subtense tacheometry - Contouring Areas and volumes - Area calculation – Volume calculation from spot levels – earth work calculation - mass haul diagram.

**Module 5:**

Curve Surveying and Modern Surveying Instruments: Curve surveying - Definitions, designation of curve, elements of simple curve - settings of simple circular curve.

Modern surveying instruments: Total station: Types and measurements - GPS – Principles – Satellite navigation system – Remote sensing and GIS – Introduction – Advantages - Applications in Civil Engineering.

**Engineering Surveying Laboratory:**

1. Design of a parking facility by conducting chain surveying
2. Preparation of a residential layout plan by traversing
3. Calculate the distance between two distinct objectives indirectly by using Theodolite
4. Determine the height of a flag post using Theodolite
5. Preparation of a map showing the boundary of a given area using Plane table survey
6. Determine the gradient of a given stretch of the road using Dumpy level
7. Calculate the volume of earth work involved for the extension of a basket ball court by using Dumpy level
8. Verify the camber percentage on a given road by performing longitudinal and cross section levelling
9. Measurement of horizontal distance by Stadia tacheometry
10. Setting out a circular curve connecting two railway lines
11. Computation of a straight-line distance between two buildings using GPS data

12. Measurement of horizontal and vertical distances using total station
13. Distance, gradient, and difference of height between two inaccessible points using Total station.

**Textbooks:**

1. Surveying (Vol. I and II). S. K. Duggal, 4th Edition ,Tata McGraw Hill

**Reference:**

1. Surveying and Leveling, Vol I & II, Kanetkar and Kulkarni, 24th edition, Pune Vidyarthi Griha, Pune.
2. Surveying, R Agor, Khanna Publishers
3. Surveying and Leveling, Vol I & II, III, B.C.Punmiya , Laxmi Publication
4. Concepts and Techniques of GIS, Lo C.P.Yeung A K W, Prentice Hall, India
5. Remote sensing and GIS, K. Anjali Rao , BS Publications
6. Surveying and Leveling. N.N.Basak,1st Edition ,Tata McGraw Hill37
7. Introduction to GIS, Kang-tsung Chang, Tata McGraw Hill

**Course Code:** CE 2208  
**Course Name:** Fluid Mechanics  
**Credits:** 4 (3-0-2)  
**Course Position:** Semester 4

**Course Content:**

**Module 1:** Fluid properties and fluid statics: Definition of a fluid; Differences between fluids and solids; Fluid properties: mass density, specific weight, specific volume, specific gravity, viscosity, compressibility and bulk modulus (including ideal gas law), surface tension, capillarity, vapor pressure; Pascal's law; Hydrostatic pressure and pressure variation in fluids at rest; Absolute pressure and gauge pressure (measurement of pressure); Manometers; Hydrostatic forces on plane and curved surfaces; Buoyancy, flotation and stability; Metacenter and metacentric height

**Module 2:** Fundamentals of fluid flow and fluid kinematics: Lagrangian and Eulerian descriptions; Streamlines, streaklines and pathlines; Types of flow: compressible, incompressible, viscous, inviscid, rotational, irrotational, laminar, turbulent, internal and external; Equation of continuity; Material derivative; Velocity field and acceleration field (including temporal and convective components of acceleration); Stream function and velocity potential; equations of streamlines.

**Module 3:** Introduction to fluid dynamics: Forces acting on a fluid in motion; Euler's equations of motion; Bernoulli's equation and its derivation; Applications of Bernoulli's equation (Venturi meter, Pitot tube, free liquid jet, etc.); Impulse-momentum equation and its applications: force exerted by a flowing fluid on a pipe bend, force exerted by a jet on a plate, etc.; Navier-Stokes equations (significance and derivation); flow through pipes (including losses, branching pipe problems and simple pipe networks).

**Module 4:** Orifices, mouthpieces, notches and weirs: Types and uses of orifices and mouthpieces; Hydraulic coefficients of an orifice; Flow through a large rectangular orifice; Types of mouthpieces; Flow through mouthpieces; Time required to empty a tank through an orifice or a mouthpiece with no inflow; Types of notches and weirs; Applications of notches and weirs; Flow over a rectangular sharp-crested weir or notch; Flow over a triangular weir or notch; Flow over a trapezoidal weir or notch.

**Module 5:** Dimensional analysis and flow around immersed bodies: Introduction to dimensional analysis; Dimensions of physical quantities; Dimensional homogeneity; Rayleigh's indicial method; The Buckingham pi theorem; Types of similarity / similitude (geometric, kinematic and dynamic); Model investigations in fluid mechanics; Common dimensionless groups in fluid mechanics: Reynolds number, Froude number, Mach number, etc.; Introduction to the concepts of boundary layer, drag and lift.

**List of Experiments:**

Reynold's apparatus

2. Discharge over notch
3. Bernoulli's theorem
4. Venturimeter, orificemeter & rotameter calibration set-up
5. pitot tube apparatus
6. Centrifugal pump test rig
7. Flow through orifice and mouthpiece
8. Pelton turbine test rig
9. Loss due to pipe fittings, sudden enlargement& contraction
10. Loss due to friction in pipes .

**Textbooks:**

1. Munson, B.R., Young, D.F., Okiishi, T.H. and Huebsch, W.W., Fundamentals of Fluid Mechanics, 6th edition, Wiley, 2010.
2. Douglas, J.F., Gasiorek, J.M., Swaffield, J.A. and Jack, L.B., Fluid Mechanics, 5<sup>th</sup> edition, Pearson Education, 2005.
3. Modi, P.N. and Seth, S.M., Hydraulics and Fluid Mechanics including Hydraulic machines, 21st edition, Standard Book House, 2017

**Reference:**

1. Fox, R.W., McDonald, A.T. and Pritchard, P.J., Fluid Mechanics, 8th edition, Wiley, 2015.
2. Som, S.K., Biswas, G. and Chakraborty, S., Introduction to Fluid Mechanics and Fluid Machines, 3rd edition, McGraw Hill Education, 2012.
3. Cengel, Y.A. and Cimbala, J.M., Fluid Mechanics, 3rd edition, McGraw Hill Education, 2014



**Course Code:** CE 2209  
**Course Name:** Concrete Technology  
**Credits:** 3 (2-0-2)  
**Course Position:** Semester 4

**Course Content:**

**Module 1: Cement & Hydration**

Production, composition, and properties, cement chemistry, bogue's compounds, hydration process, types of cements, special cements.

**Module 2: Aggregates: Mineralogy, properties, tests and standards, Alkali silica reaction Admixtures: Water reducers, air entrainers, set controllers, specialty admixtures - structure properties, and effects on concrete properties, Introduction to supplementary cementing materials and pozzolans, their production, properties, and effects on concrete properties.**

**Module 3: Mix design**

Basic principles; IS method; ACI method; new approaches based on rheology and particle packing, Batching of ingredients, mixing, transport, and placement, Consolidation, finishing, and curing of concrete.

**Module 4: Concrete production, Fresh & Hardened properties**

Fresh concrete: workability tests on concrete, setting times of fresh concrete, segregation and bleeding.

Hardened concrete: Compressive strength and parameters affecting it, Tensile strength - direct and indirect, Modulus of elasticity and Poisson's ratio, Stress strain response of concrete, Chemical attack of concrete; corrosion of steel rebars; other durability issues.

**Module 5: New technologies for sustainable concrete**

High strength - high performance concrete, reactive powder concrete, Lightweight, heavyweight, and mass concrete; fibre reinforced concrete; self-compacting concrete; shotcrete; other special concretes

Limestone calcined clay concrete, 3D printing technology

**List of Experiments: -**

List of Experiments:-

**1) Test on Cements & Supplementary Cementitious Materials:**

Specific Gravity, Fineness, Standard Consistency, Setting time, Compressive strength and Soundness test.

**2) Test on Aggregates:**

Specific gravity of fine and coarse aggregate, Fineness Modulus for fine and coarse aggregate, Bulking of Sand, Water Determination of Absorption and Moisture Content.

**3) Test on Fresh Concrete:** Slump, Vee – Bee, Compaction factor and flow test for fresh concrete; Slump flow, J-ring, V-funnel and L-box tests for Self-Compacting Concrete

**4) Tests on Hardened Concrete:** Split tensile strength, modulus of rupture, young's modulus, compressive strength, Flexural Strength, Non-Destructive Testing, Rebound Hammer and Ultrasonic Pulse velocity test

**5) New Technologies:** Demonstration of experiments on Alkali Activated Concrete, Fibre Reinforced Concrete, 3D Printable Concrete

**Textbooks:**

1. Concrete technology by A.M. Neville & J J Brooks, Low price edition 2004, Pearson Education
2. Concrete Technology by M.S. Shetty, S. Chand & Co

**References:**

1. Concrete Technology by M.L. Gambhir, McGraw Hill Education (India) Pvt. Ltd, 5th edition 2.
2. Concrete – Microstructure, properties and materials by P. Kumar Mehta & Paulo J.M.
3. Monteiro- 3rd edition published by Tata Mc Graw Hill Education Pvt. Ltd. 3.
4. Properties of concrete by A.M. Neville, Pearson publishers.

**Course code:** HS 2201  
**Course Name:** Design Thinking  
**Credits:** 2 (1-0-2)  
**Course Position:** Semester 4

**1<sup>st</sup> week:**

Exercise 1: Drawing practice using subconscious mind with the help of music.... Al Di Meola (Race with Devil on Spanish Highway), Beethoven Symphony No.9, Hans Zimmer - Kings of the Past, Pink Floyd - Terminal Frost etc. Another exercise was to create a story from subconscious mind.

Exercise 2: 2D drawing from conscious mind and create a story.

Exercise 3: 2D Story making following story board & comic strips type.

**2<sup>nd</sup> week:**

Introduction 3D, where 'D' stands for dimension, which means an object has three dimensions. X-axis, Y-axis and extra dimension are the Z-axis which gives height/width/depth to an object.

Exercise 1: Composition exercise 3D, Create a new 3d compound structure using any one symmetrical and asymmetrical pattern with the help of colour paper

**3<sup>rd</sup> week:**

3d exploratory prototyping/ connection of variety objects....Bangles, Rubber band, Scooby sticks, Marbles, Paper cups. This is a brain storming activity. Where they will learn how to build a product with the help of very limited object and also they need to calculate the mathematical way to function this game.

**4<sup>th</sup> week:** 2D form exploration Tangram

**5<sup>th</sup> & 6<sup>th</sup> weeks:**

Screening short films.

Exercise 1: First write down the basic theme.

Exercise 2: To identify and write down the visual and audio components of this design/narrative and also to state alongside as to what could be its motivation.

**7<sup>th</sup> week:**

Context-Concept- We are providing some objects (Syringe, Nail Cutter, and Stapler). Brain storms the following using object which is given them. Note the idea, possibilities and connection as possible.

- In what contexts do you see a use for this product?
- How did this product evolve? What are the alternatives before the product for the same need? What the problem did this product solve?
- Think of 5 important “WHAT IF CONTEXTS” for this product?
- Describe a PERSONA of the product.
- Sketch your 10 new concepts based on this product.
- What can be made it simpler, pleasurable and more meaningful?

### **(8<sup>th</sup> week)**

Typography & Photo montage (collage) – History of typography/ Calligraphy and Photomontage. Typography plays a *critical* role in strengthening the brand, creating interest to the product, and highlighting a central message. The core purpose of a design is communication. Whether we're talking about an online ecommerce store or a corporate brochure, typography is a vital component. Typography is the art and technique of selecting and arranging type styles/fonts for texts.

Exercise 1: To write their name in two different styles (Serif and Calligraphy).

Exercise 2: Making a collage art using magazine and newspaper.

### **9<sup>th</sup> week**

Book Cover Design: History and evolution of book. History of book covers designing.

Exercise 1: Create a book cover by using typography or any kind of creative image which can describe the book visually.

### **10<sup>th</sup> week**

Ideating objects & Mechanical transformation-

Problem review

- Identify the object.
- User profile of the product.
- Function of the product.
- How many parts is the product made of?
- How is each part manufactured?
- What manufacturing processes are applied?
- What are the alternatives uses the product?
- What are the irritants present in this product?
- If the product had to be redesigned, what would be your approach? Sketch the design.

### **11<sup>th</sup> to 15<sup>th</sup> weeks**

*‘Final Project and Prototype.*

**Course Code:** HS 2202  
**Course Name:** French Language and Culture IV  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 4

### **Objectives:**

The aim of this course is to understand very short, simple information in the spoken and written language and to express oneself simply and briefly in speech and in writing for practical purposes in everyday situations requiring a direct exchange of information. It is expected that productive skills will be limited and fragmented and that language will be mostly or completely formulaic at this level; receptive skills will be more developed than productive skills.

### **Course Content:**

#### **General themes**

- Accommodation: Units in the house, interior decor
- Everyday objects
- Countries & Cities
- Actions in daily life
- Events: Meetings, Evening out, Family events, Visits, Excursions, Accidents, TV news
- Money and payments

#### **Grammar topics**

- Transitive and Intransitive verbs - Direct and Indirect object
- Relative pronoun 'there' - place
- Relative pronouns - who, that/which
- Prepositions of place: go to, be at, come from + a place
- Connectors: but, because

**Course Code: CE 3110**  
**Course Name: Transportation Engineering**  
**Course Credits: 4 (3-0-2)**  
**Course Position: Semester 5**

### **Course contents**

**Module 1:** Introduction to transportation modes – History of highway development - classification of roads - road patterns - planning surveys - saturation system – Highway planning in India – Highway alignment – requirements for an ideal alignment - factors controlling – engineering surveys – Highway economics

**Module 2:** Highway Geometric design - cross-section elements – camber - sight distance - design of horizontal alignment – super-elevation - transition curves – widening of pavement – setback distance - curve resistance - vertical alignment – grade compensation

**Module 3:** Traffic characteristics- Road user and vehicular characteristics - traffic studies and surveys – speed studies, volume studies, parking studies, accident studies – traffic signs and markings - intersections & rotaries – design of rotary intersection

**Module 4:** Material requirement for pavements – soil, aggregates, bitumen – properties - material testing and specification – Marshall's mix design – pavement construction and maintenance

**Module 5:** Highway pavement design - Design factors - design of flexible pavement: CBR method – stresses in rigid pavements - design of rigid pavements: IRC method – joints in rigid pavements

#### Tests on aggregates

1. Determination of crushing strength of given aggregate sample
2. Determination of abrasion value of given aggregate sample by conducting Los Angeles abrasion test
3. Determination of impact value of aggregates

#### Tests on bitumen

4. Determination of Specific gravity of given bituminous material
5. Determination of penetration value of bituminous material
6. Determination of ductility of the bitumen sample
7. Determination of softening point of bituminous material
8. Determination of Flash and fire point of bituminous material
9. Determination of viscosity of bituminous material
10. Bituminous mix design by Marshall method

#### **Text Books:**

1. S K Khanna and C E G Justo, Highway Engineering

#### **References**

2. S K Sharma, Principles, Practice, and Design of Highway Engineering

3. Kadiyali, L.R. Principles and Practice of Highway Engineering
  4. Vazirani and Chandola, Transportation Engineering Vol.1 and Vol. 2
  5. Fred L. Mannering, Scott S. Washburn and Principles of Highway Engineering and Traffic Analysis.
  6. Khanna, S.K., and Justo, C.E.G. “ Highway Material Testing Laboratory Manual”, Nem Chand & Bros, Roorkee.
  7. Indian standard specification for paving bitumen, IS 73: 2013
- Duggal, Ajay. K. and Puri, Vijay P. “Laboratory Manual in Highway Engineering”, New age internationa

**Course Name: Construction Technology**  
**Course Code: CE 3111**  
**Course Credits: 2 (2-0-0)**  
**Course Position: Semester 5**

## **Course Content**

### **Module 1:**

Introduction and role of technologies; Construction technologies in RC buildings for reinforcement and concreting activities, concreting under water, concreting in different weather conditions; Prefab construction.

### **Module 2:**

Formwork material and design concepts, formwork systems for foundations, walls, columns, slab and beams and their design, climbing formwork, tunnel form, slipform, heavy duty tower system.

### **Module 3:**

Tunneling method - Drilling and blasting method, mechanical means, NATM, TBM, mucking, ventilation of tunnels, dust control, types of tunnel supports, tunnel lining, cycle time in tunneling operations.

### **Module 4:**

Bridge construction - Launching of bridges by incremental launching, using false work, balanced cantilever construction method; Ground improvement techniques; Automation in construction.

### **Module 5:**

Factors affecting selection of equipment - technical and economic, earthmoving equipment, drilling and blasting equipment, pile driving equipment, stone crushing equipment, concrete manufacture, transport, placing and compacting equipment, equipment cost, operating cost, buy rent and lease options.

### **Text Books:**

- □ R.L. Purifoy & Ledbetter - Construction Equipment and its Planning , McGraw hill

### **Reference Books:**

Thomas baron, Erection of Steel Structures  
Stubbs, Handbook of Heavy Construction  
Dr. P. Purushothama Raj, Ground Improvement Techniques, Laxmi Publications  
Jagdish Lal, Construction Equipment  
Varma Mahesh, Construction Equipment and its Planning & Applications



**Course Code:** CE 3112  
**Course Name:** Computing Lab (Design Studio)  
**Credits:** 2 (0-0-4)  
**Course Position:** Semester 5

**Course Content:**

**Module 1 :** Introduction to CAD and BIM: Introduction to basic principles of Computer-Aided Design (CAD).

Introduction to Building Information Modelling (BIM), both as a virtual prototype and a working method, as well as the theoretical differences between the working methods of CAD and BIM designs.

**Module 2:** Linear Programming (MATLAB): DBMS concepts, Civil Engineering Databases, Manipulation, Spreadsheet concepts, Worksheet calculations in Civil Engineering, Regression, Matrix Inversion, etc.,

**Module 3:** CAD Basic Modeling and Analysis: STAAD Pro / ETABS / SAP2000: Modeling and analysis of 2D and 3D buildings using IS Codes. Two and three dimensional beams with various loads and comparison with classical solution, two and three dimensional frames. Analysis for various load combinations.

**Module 4:** CAD Modeling and Analysis of Special Structures  
STAAD Pro / ETABS / SAP2000: Modeling and analysis of special structures like Stadium, Cable-stayed bridges.

**Module 5:** CAD Analysis using ANSYS  
ANSYS: Modeling and analysis of 2D and 3D beams for different loads including temperature.

**Textbooks:**

1. Chapra, S.C., and Canale R.P., Numerical Methods for Engineers, McGraw - Hill, 2004
2. Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, Oxford, 2010

**References:**

1. Krishnamoorthy, C.S. and Rajeev, S., Computer Aided Design and Analytical Tools, Narosa, 1993
2. Li Quan Bian Zhu, ANSYS in Civil Engineering, People Post, 1991



**Course Code:** CE 3113  
**Course Name:** Reinforced Concrete Design

**Credits:** 4 (3-1-0)

**Course Position:** Semester 5

**Course Content:**

**Module 1:** Concepts of RC. Design – Working Stress Method – Limit State method – Material Stress Strain Curves – Safety factors – Characteristic values. Stress Block parameters – IS – 456 – 2000. Beams: Limit state analysis and design of singly reinforced, doubly reinforced, T and L beam sections.

**Module 2:** Limit state analysis and design of section for shear and torsion – concept of bond, anchorage and development length, I.S. code provisions. Design and detailing of cantilever, simply supported and continuous beams.

**Module 3:** Design and detailing of one way slab, Two-way slabs and continuous slab Using IS Coefficients, Limit state of serviceability for deflection, cracking and codal provision. Design and detailing of doglegged staircase.

**Module 4:** Design and detailing of Compression members (Columns) – under axial loads, uniaxial bending and biaxial bending – I S Code provisions.

**Module 5:** Design and detailing of Isolated and Combined footing.

**Textbooks:**

1. Reinforced concrete design by S. Unnikrishna Pillai & Devdas Menon, Tata McGraw Hill, New Delhi.
2. Reinforced concrete design by N. Subrahmanian Oxford University Press.
3. Limit state designed of reinforced concrete – P. C. Varghese, Prentice Hall of India, New Delhi

**Standards:**

IS 456:2000 Indian Standard PLAIN AND REINFORCED CONCRETE – CODE OF PRACTICE, BIS, New Delhi.

IS 875 (Part 1-5) Code of practice for design loads (other than earthquake) for buildings and structures

**References:**

1. Design of Reinforced Concrete Structures by I. C. Syal and A. K. Goel, S. Chand & company.
2. Fundamentals of reinforced concrete by N.C. Sinha and S.K Roy, S. Chand publishers
3. Design of concrete structures – Arthur H. Nilson, David Darwin, and Charles W. Dolar, Tata McGraw-Hill, 3rd Edition, 2005
4. Park, R., and Paulay, T. Reinforced Concrete Structures, John Wiley and Sons, 1975
5. Dayaratnam, P. Design of Reinforced Concrete Structure 4th Ed., Oxford and IBH, 2011

**Course Code: CE 3114**

**Course Name: Soil Mechanics**

**Credits: 4 (3-0-2)**

**Course Position: Semester 5**

**Course Content:** Module 1: INTRODUCTION: Origin- Soil formation – soil structure and clay mineralogy – Diffused double layer theory – Mass- volume relationship. INDEX PROPERTIES OF SOILS: Grain size analysis – Sieve and Hydrometer methods – consistency limits and indices – I.S. Classification of soils, Relative density.

Module 2: PERMEABILITY: Soil water – capillary rise – flow of water through soils – Darcy's law- permeability – Factors affecting – laboratory determination of coefficient of permeability – Permeability of layered systems. In-situ permeability tests (pumping-in and pumping-out tests)

SEEPAGE THROUGH SOILS: Total, neutral and effective stresses – quick sand condition – Seepage through soils – Flow nets: Characteristics and Uses.

Module 3: STRESS DISTRIBUTION IN SOILS: Boussinesq's and Westergaard's theories for point loads and areas of different shapes – Newmark's influence chart. COMPACTION: Mechanism of compaction – factors affecting – effects of compaction on soil properties. – Field compaction Equipment – compaction quality control.

Module 4: Spring Analogy-Void ratio and effective stress ( $e$  vs  $\log p$  relationship- Terzaghi's theory of one-dimensional consolidation – Assumptions and derivation of Governing Differential Equation (GDE)-Computation of magnitude of settlement and time rate of settlement

Module 5: SHEAR STRENGTH OF SOILS: Importance of shear strength-Mohr's – Coulomb's Failure theories – Shear Parameters-Laboratory tests for determination of strength tests – Direct shear test, Tri-axial compression test (UU, CU and CD) unconfined compression tests- Vane shear test. Factors affecting shear strength of cohesion less and cohesive soils- Determination of elastic moduli.

### **Lab syllabus**

Grain-size Analysis Method

Atterberg's Limits

Field density-core cutter method

Sand replacement method

Permeability of soil, constant head test

Permeability of soil, variable head test

Compaction test

Consolidation test

Unconfined compression test

Direct shear test.

Vane shear test

CBR Test

**Text Books:**

Geotechnical Engineering by C. Venkatramaiah, 5<sup>th</sup> Edition, New Age International Publishers

**Reference Books:**

- Soil Mechanics and Foundation Engineering by K.R. Arora, Standard Publishers
- Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publishers
- Soil Mechanics and Foundations by Muniram Budhu, John Wiley and Sons
- Principles of Geotechnical Engineering by B.M. Das and K. Sobhan, Cengage Learning
- Soil Mechanics by Craig R.F., Chapman & Hall

**Course Code: CE 3115**

**Course Name: Water Resources Engineering**

**Credits: 3 (3-0-0)**

**Course Position: Semester 5**

**Course Content:**

**Module 1:** Introduction- irrigation, water resources in India, need of irrigation in India, development of irrigation in India, impact of irrigation on human environment, irrigation systems: minor and major, command area development. Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships- soil characteristics significant from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle / drip irrigation.

**Module 2:** Hydrology- hydrologic cycle, rainfall – runoff process, factors affecting runoff, runoff hydrograph, runoff computations, flood discharge calculations, unit hydrograph method, S-hydrograph.

**Module 3:** Ground water and well hydrology- Ground water resources, occurrence of ground water, methods of ground water exploration, well irrigation; Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests, design of water wells.

**Module 4:** Distribution system-Canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels carrying clear and sediment laden water, alluvial channels carrying clear and sediment laden water, Kennedy's and Lacey's theory of regime channels. Canal outlets: non-modular, semi-modular and modular outlets. Water logging: causes, effects and remedial measures. Lining of canals economics of lining, types of lining. Drainage of irrigated lands: necessity, methods. Canal structures- Surface and sub-surface flow considerations for design of canal structures: hydraulic jump, seepage forces, uplift forces. Canal falls, cross regulator, distributory head regulator, canal escapes: types, components and design considerations. Canal head works- Weir and barrage, different units of head works, types of weirs, sediment control in canals, river training for canal head works. Theories of seepage for design of weirs: Bligh's creep theory, Lane's weighted creep theory, Khosala's method of independent variables.

**Module 5:** Dams and spillways-Embankment dams: Classification, selection of site for dam, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile, structural joints, keys and water seals, galleries, outlets. Arch and buttress damstypes. Spillways: components of spillways, types, terminal structures, types of gates for spillway

crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site, flood routing.

**Text Books:**

G L Asawa, Irrigation Engineering, Wiley Eastern

S K Garg, Irrigation Engineering & Hydraulic Structures, Khanna Publishers

P N Modi, Irrigation Engineering & Hydraulic Structures

**Reference Books:**

J D Zimmerman, Irrigation, John Wiley & Sons

Varshney, Gupta & Gupta, Theory and Design of Irrigation Structures, Nem Chand & Bros.



**Course Code:** HS 3101  
**Course Name:** French Language and Culture V  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 5

**Objectives:**

At this level the students work in class on understanding and expressing feelings, intentions, opinions and routine tasks in order to interact with relative facility in their specific field of activities. Students are able to discuss ideas with frequently used language and can ask for information about familiar subjects concerning everyday subjects and the news. They also work on comprehension skills and writing notes. They work on improving their grasp of everyday syntax and grammar and build a lexical base corresponding to immediate needs. They also work on targeted pronunciation to improve clarity of expression.

**Course Content:**

• **Topics**

1. To accept or to refuse any invitation
2. Showing possession
3. Description of an object
4. Expressing comparison
5. To express an idea
6. Description of a landscape

• **Grammar**

1. Revision of l'imparfait (Past Continuous), le Futur simple (Simple future) et le passé composée (Simple Past)
2. Possessive Pronouns
3. Place of Adjectives
4. Recent Past
5. Forms of negation

• **Types of writing**

1. Informal letter or email
2. A short passage



**Course Code:** PR 3201  
**Course Name:** Year-3 Team Project  
**Credits:** 3 (0-0-6)  
**Course Position:** Semester 6

**Course Content:**

The Year-3 team project can focus on any topic or problem of relevance to civil engineering and its allied fields. Students are expected to make use of the knowledge gained in their coursework over the first 5 semesters, as well as knowledge from other relevant subjects, in order to conduct a detailed theoretical / analytical, experimental, or computational study of a problem of their own interest. Alternatively, the topic of the project may be suggested by the faculty advisor supervising the project. Project topics involving knowledge from multiple disciplines are especially encouraged, as these will broaden the students' view of the engineering profession and its interfaces with other disciplines.

The Year-3 team project is intended to help the students develop a set of key skills to become innovative engineers. It encompasses:

**Teamwork:** Development of organization skills, decision-making skills, and managerial skills within the framework of a team-based task; Roles and performance of team members; Written and oral communication: Structure and synthesis; Enhancement of written and oral impact; Interpersonal communication and public communication; Development of skills for solving complex problems: Framing the issue; Inductive, experimental and recursive approaches; Handling doubts and complexity.

**Creativity:** Enhancement of creative skills through group creativity methods; Skills needed to build one's academic and career plans; Exposure to the work of practicing engineers / researchers.

**Textbooks:**

1. Case studies based teaching and problem based learning
2. A Guide to the Project Management Body of Knowledge: PMBOK Guide (Fifth Edition), PMI Project Management Institute.
3. Project Management: A Systems Approach to Planning, Scheduling, and Controlling (11th Edition), Harold Kerzner.
4. Managing Complex Projects (The IIL/Wiley Series in Project Management) International Institute for Learning, Harold R. Kerzner, Carl Belack.
5. Project Management: from Simple to Complex, v. 1.0; Russell Darnall and John M. Preston.

**Course Code:** CE 3216  
**Course Name:** Design of Steel Structures  
**Course Credits:** 4 (3-1-0)  
**Course Position:** Semester 6

### Course contents

#### Module 1:

Mechanical properties of steel, cold working and strain hardening; Philosophy, concept and methods of design of steel structures.

Bolted/Riveted Connections: Types: Ordinary and friction-grip bolts, Prying Action; Simple Connections: Lap and butt joints, hanger joints, beam-column and beam-beam connections.

Welded Connections: Types: groove and fillet welds, specifications, Simple Connections: Lap and butt joints, beam-column and beam-beam connections, beam splice.

**Module 2:** Design of tension members: Types, modes of failure, angles under tension; Shear-lag effects – Block shear failure – Welded tension members, lug angles; tension members in trusses.

**Module 3:** Design of compression members: Effective length factors and degree of restraints; Trusses and columns – Built-up Compression members – Members with two components back-to-back.

**Module 4:** Design of laterally supported beams: holes in tension zones – shear-lag effects – Design of laterally unsupported beams: Lateral-torsional Buckling; Elastic-critical moment – Shear buckling of webs – Web buckling and web crippling.

**Module 5:** Design of Beam-Column: Second order moments (P-delta effect) – Lateral torsional buckling – Bi-axial loading – Beam-columns subjected to tension and bending – Moment-Resisting Connections.

*Conclusion on course projects and special guest lecture by industry expert.*

#### Text books:

1. Subramanian, N., 2010. *Design of steel structures*. Oxford University Press.
2. Duggal, S.K., 2010. *Limit State Design of Steel Structures, 2e*. Tata McGraw-Hill Education.

#### Reference books:

1. Salmon, C.G., Johnson, J.E. and Malhas, F.A., 2009. *Steel structures design and behavior*, Pearson.
2. Owens, G.W. and Cheal, B., 1989. *Structural steelwork connections*. Butterworth Heinemann.

**Relevant IS Codes:** IS:800-2007, IS-808-1989, SP:6(1)-1964.

**Course Code:** CE 3217  
**Course Name:** Environmental Engineering  
**Course Credits:** 3 (2-0-2)  
**Course Position:** Semester 6  
**Course Contents**

**Module 1: Water:-** Water Supply systems, Need for planned water supply schemes, Sources of Water, Water demand and Potable, industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.

**Module 2: Sewage-** Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage, sewer appurtenances, Design of sewerage systems. Storm Water- Quantification and design of Storm water; Principles and Design of Screens, Grit Chambers, Skimming Tanks, Sedimentation Tanks, Trickling Filters-Standard and High Rate, Construction and Design of Oxidation Ponds, Sludge Digestion Tanks and The Factors That Decide the Design. Sludge Disposal by Drying, Septic Tanks and Their Working Principles and Design of Soak Pits.

**Module 3: Air -** Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution. Air quality standards, Control measures for Air pollution, construction and limitations. Noise- Basic concept, measurement and various control methods.

**Module 4: Solid waste management-**Municipal solid waste (MSW), MSW management, Special MSW, Effects of solid waste on environment. Disposal of solid waste, Disposal methods- Integrated solid waste management. Hazardous waste.

**Module 5: Building Plumbing-** home plumbing systems for water supply and waste water disposal and high-rise building plumbing. Government authorities and their roles in water supply, sewerage disposal.

**Practical work:**

1. Determination of acidity of water sample
2. Determination of total solids, total dissolved solids and total suspended solids in water
3. Determination of temporary and permanent hardness of water sample
4. Determination of optimum coagulant dosage of water sampling using jar test
5. Determination of chloride content of water sample
6. Determination of dissolved oxygen of water sample
7. Determination of biochemical oxygen demand of water sample
8. Determination of Metal (Iron or Arsenic) in Water
9. To determine Fecal Count of a given sewage sample
10. To determine Sulphate Concentration in a given water sample
11. Determination of particulates in air.
12. To determine the composition of MSW

**Text Books:**

Introduction to Environmental Engineering by P. Arne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition 2008

Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000

**Reference Books:**

Water Supply and Sewerage, E.W. Steel

CPHEEO Manual on Water Supply & Treatment

Manual on Water Supply and Treatment, (latest Ed.), Ministry of Works & Housing, New Delhi.

Plumbing Engineering. Theory, design and Practice, S.M. Patil, 1999

Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication

Environmental Engineering by H.S.Peavy, D.R. Rowe, G.Tchobanoglous; 1991, Tata McGraw Hill

**Course Code: CE 3218**

**Course Name: Foundation Engineering**

**Course Credits: 3 (3-0-0)**

**Course position: Semester 6**

### **Course Content**

**Module 1:** Site Investigations: Need – Methods of soil exploration – Boring and Sampling methods – Field tests – Standard penetration test, cone penetration test, Plate load test – Planning of Program and preparation of soil investigation report.

**Module 2:** Stability of Earth Slopes: Infinite and finite earth slopes – Types of failures – Factor of safety of finite slopes – Stability analysis by Swedish slip circle method, standard method of slices, Taylor's Stability Number-Stability of slopes of earth dams under different conditions.

**Module 3:** Earth Pressure Theories: Different Types of Earth Pressures, Rankine's theory- Computation of Active and Passive Earth Pressures in Cohesion less and Cohesive soils, Coloumb's wedge theory, Cullman's Graphical Method.

**Module 4:** Shallow Foundations: Types-Choice of Foundation-Location of Depth-Safe bearing capacity-Terzaghi, Meyerhof, Brinch Hansen and IS methods- Effect of water table– Settlement criteria – Safe bearing pressure based on N Value-Allowable bearing pressure: Safe bearing capacity- Allowable settlement of structures- contact pressure-immediate settlements.

**Module 5:** Pile Foundations: Classification of piles– selection of Pile-Load carrying capacity of piles based on static pile formulae in different soils – Dynamic pile formulae – Pile load tests - Load carrying capacity of pile groups in sands and clays – Settlement of pile groups-Negative skin friction.

### **Text**

Geotechnical Engineering by C. Venkatramaiah, 5th Edition, New Age International Publishers

### **Books:**

### **Reference Books:**

1. Soil Mechanics and Foundation Engineering by K.R. Arora, Standard Publishers  
Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publishers
2. The Engineering of Foundations by Rodrigo Salgado, McGraw Hill
3. Theory and Practice of Foundation Design by N.N. Som and S.C. Das, Prentice Hall
4. Principles of Geotechnical Engineering by B.M. Das and K. Sobhan, Cengage Learning

**Course Code: CE 4119**  
**Course Name: Hydraulics & Hydraulic Machines.**  
**Course Credits: 2 (2-0-0)**  
**Course position: Semester 6**

**Module I:**

OPEN CHANNEL FLOW: Types of flows - Type of channels – Velocity distribution – Energy and momentum correction factors – Chezy's, Manning's; and Bazin formulae for uniform flow – Most Economical sections. Critical flow: Specific energy-critical depth – computation of critical depth – critical sub-critical and super critical flows.

Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep, horizontal and adverse slopes-surface profiles-direct step method- Rapidly varied flow, hydraulic jump, energy dissipation.

Dimensional analysis-Rayleigh's method and Buckingham's pi theorem-study of Hydraulic models – Geometric, kinematic and dynamic similarities-dimensionless numbers – model and prototype relations.

**Module 2:**

BASICS OF TURBO MACHINERY: Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity triangles at inlet and outlet, expressions for work done and efficiency-Angular momentum principle, Applications to radial flow turbines.

**Module 3:**

HYDRAULIC TURBINES – I: Layout of a typical Hydropower installation – Heads and efficiencies-classification of turbines-pelton wheel-Francis turbine-Kaplan turbine-working, working proportions, velocity diagram, work done and efficiency, hydraulic design, draft tube – theory and function efficiency.

**Module 4:**

HYDRAULIC TURBINES – II : Governing of turbines-surge tanks-unit and specific turbines-unit speed-unit quantity-unit power-specific speed performance characteristics-geometric similarity-cavitation.

**Module 5:**

CENTRAIFUGAL-PUMPS : Pump installation details-classification-work done- Manometric head-minimum starting speed-losses and efficiencies-specific speedmultistage pumps-pumps in parallel- performance of pumps-characteristic curves- NPSH-cavitation.

**TEXT BOOKS:**

1.Open Channel flow by K,Subramanya . Tata Mc.Grawhill Publishers.



2. Fluid Mechanics, Hydraulic and Hydraulic Machines by Modi & Seth, Standard book house.
3. Fluid Mechanics & Fluid machines by Narayana pillai, Universities press.

**REFERENCE BOOKS:**

1. A text of Fluid mechanics and hydraulic machines by Dr. R.K. Bansal - Laxmi Publications (P) ltd., New Delhi
2. Elements of Open channel flow by Ranga Raju, Tata Mc.Graw Hill, Publications.
3. Fluid mechanics and fluid machines by Rajput, S.Chand &Co.
4. Open Channel flow by V.T.Chow, Mc.Graw Hill book company.

**Course Code:** HS 3201  
**Course Name:** Introduction to Professional Development (Fractal).  
**Course Credits:** 2 (2-0-0)  
**Course position:** Semester 6

**Mode:** Lectures, Games & Workshops

**Course Description:**

This course provides students with knowledge of the prerequisite skills for general employment as well as the means of obtaining those skills enabling them to navigate the journey of applying for jobs and getting gainfully placed. Employability skills include fundamentals of maintenance of personal appearance, grooming and protocols of etiquette in the corporate world. The course also includes the knowledge, skills, and attitudes (KSA's) that allow employees to get along with their co-workers, make important work-related decisions, and become strong members of the work team. Discovering job possibilities that link skills, abilities, interests, values, needs, and work environment preferences is a part of the process of obtaining employability skills and abilities and is experiential learning that takes place over time. This course is designed to guide students in obtaining the knowledge and the needed employability skills that are transferable among a variety of jobs and careers and are considered essential in any employment situation. Students will learn and apply basic knowledge of what is expected in the workplace.

**OBJECTIVES OF THE COURSE:**

The course will aim at

- exposing the students to the basic principles of communication.
- helping students hone their receptive (listening and reading) as well as expressive (written and oral) communication skills.
- training students in writing emails, directed towards a real audience based on a problem, situation, or need at a particular company or organization.
- enabling students to write cover letters, prepare a resume and prepare for the interview process
- exposing students to professional etiquette and the appropriate ways to groom for corporate life and the importance of body language

**EXPECTED LEARNING OUTCOMES:**

Upon completion of this course, students should be able to:

1. Demonstrate improved interpersonal communication skills. Develop improved persuasion and influencing skills.
2. Design and create effective formal and informal messages
3. Be equipped with skills to present his/her best foot forward for interviews, group discussions, case analysis etc.
4. Exhibit improved understanding of professional etiquette: Introductions, Telephone etiquette, Grooming and Body Language

**Course Code:** HS 3202  
**Course Name:** French Language and Culture VI  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 6

**Objectives:**

At this level the students work in class on understanding and expressing feelings, intentions, opinions and routine tasks in order to interact with relative facility in their specific field of activities. Students are able to discuss ideas with frequently used language and can ask for information about familiar subjects concerning everyday subjects and the news. They also work on comprehension skills and writing notes. They work on improving their grasp of everyday syntax and grammar and build a lexical base corresponding to immediate needs. They also work on targeted pronunciation to improve clarity of expression.

**Course content:**

a) **Topics**

1. To Propose or to invite for a program, a party etc.
2. Writing a personal letter
3. Expressing obligation and interdiction
4. To ask for the touristic information
5. To present one's point of view and argue about it
6. To understand the difference between written and spoken language

b) **Grammar**

1. Adverb
2. To know how to change verbs into noun and vice-versa
3. The Subjunctive
4. Relative pronouns
5. Expression of duration
6. Direct and Indirect speech in present
7. Basic logical connective

c) **Types of writing**

1. A short essay
2. Informal letter or email
3. Film review

**Course Code:** PR 4102  
**Course Name:** Year-4 Project  
**Credits:** 9 (0-5-8)  
**Course Position:** Semester 7

**Course Content:**

The object of Year-4 Project Work & Dissertation is to enable the student to extend further the investigative study taken up under, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from a School at MEC or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic;
2. Preparing an Action Plan for conducting the investigation, including team work;
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
4. Final development of product/process, testing, results, conclusions and future directions;
5. Preparing a paper for Conference presentation/Publication in Journals, if possible;
6. Preparing a Dissertation in the standard format for evaluation;
7. Final Seminar presentation before a Committee.

**Course Code:** CE 4120  
**Course Name:** Remote Sensing and GIS  
**Semester:** 7  
**Credits:** 2 (2-0-0)

**Course Position:**

**Course contents**

**Module 1: Triangulation** – Principles of triangulation – strength of figures - Selection of stations – inter-visibility of triangulation stations - Satellite stations – measurements and computations

**Module 2: Electronic Distance Measurement** - Introduction – Electronic distance measuring instrument – basic principle and classification - Electronic theodolite – Digital level - Total station: types and measurements

**Module 3: Photogrammetry** – Principles – Aerial photographs: basic terms and definitions – Classification – Geometry of photographs – developments – Digital Terrain Model – Digital Elevation Model – Data sources

**Module 4: GPS:** GPS principles – Satellite navigation system – GPS: Space segment, control segment, user segment – GPS satellite signals – errors and accuracy – GPS surveying techniques – applications

**Module 5: Remote sensing and GIS:** Introduction – Electromagnetic radiation – target interaction – Remote sensing systems – applications of remote sensing – Introduction to image processing technique – Geographic information system – concepts and introduction – errors and corrections – applications in civil engineering

**References:**

1. Surveying Vol. 1 and 2 by B.C. Punmia
2. Surveying Vol. 1 and 2 by K.R. Arora
3. Surveying and Levelling by R. Agor
4. Surveying Vol. II by S. K Duggal.

**Course Name: Construction Planning and Management**  
**Course Code: CE 4121**  
**Course Credits: 3 (2-0-2)**  
**Course Position: Semester 7**

### **Course Content**

#### **Module 1:**

Introduction to construction projects, stakeholders, phases in a project, bidding process, types of contracts, contract documents, specification, important conditions of contract, construction claims and disputes.

#### **Module 2:**

Quantity take-off, cash flow diagram, time value of money and NPV concept, cost estimation from clients and contractors' perspective.

#### **Module 3:**

Project planning and network analysis – Bar chart, CPM, PERT, and Precedence Network; Time Cost trade-off analysis; Project planning using project management software.

#### **Module 4:**

Resource planning – planning for manpower, materials, equipment, costs; Resource levelling and allocation; Resource planning using project management software.

#### **Module 5:**

Time-cost monitoring and control – updating, S-curve, and earned value analysis; Project monitoring using project management software; Introduction to construction quality and safety.

#### **Text Books:**

Ghalot, P.S., Dhir, D.M., Construction Planning and Management, Wiley Eastern Limited, 1992.

Chitkara, K.K., Construction Project Management, Tata McGraw Hill Publishing Co, Ltd., New Delhi, 1998.

#### **Reference Books:**

Construction Management And Planning by: sengupta, b. / guha, h. tata mcgraw-hill publications.

**Course Code:** HS 4101  
**Course Name:** French Language and Culture VII  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 7

**Objectives:**

The aim is to place the students in various communication situations in French that correspond to social and professional contexts. They learn to express their ideas simply and coherently and are able to understand selective authentic French texts written in everyday language. These texts usually discuss subjects of cultural nature. Radio and television documentaries about the news or subjects linked to the students' specific area of interest are used to practice extracting key information. Students acquire sufficient vocabulary and control of the main grammatical structures to be able to express most of what they want to say relatively easily.

**Course Content:**

1. **Topics**
  - a) Intergeneration accommodation
  - b) Internet and cellphone
  - c) Pollution
  - d) Love, marriage, divorce
  - e) Carpool (Covoiturage)

The topics were studied through written articles, audio listening and television coverage. Students were also asked to do oral presentations on the above mentioned topics.

2. **Grammar**
  - e) Subjunctive
  - f) Reported speech
  - g) Connectors
3. **Types of writing**
  - b) Official letter
  - c) Argumentative essay





**Course Code:** PR 4203  
**Course Name:** Year-4 Project  
**Credits:** 9 (0-0-18)  
**Course Position:** Semester 8

**Course Content:**

The object of Year-4 Project Work & Dissertation is to enable the student to extend further the investigative study taken up under, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from a School at MEC or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

8. Review and finalization of the Approach to the Problem relating to the assigned topic;
9. Preparing an Action Plan for conducting the investigation, including team work;
10. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
11. Final development of product/process, testing, results, conclusions and future directions;
12. Preparing a paper for Conference presentation/Publication in Journals, if possible;
13. Preparing a Dissertation in the standard format for evaluation;

Final Seminar presentation before a Committee.

**Course Code:** HS 4201  
**Course Name:** French Language and Culture VIII  
**Credits:** 0.5 (0-2-0)  
**Course Position:** Semester 8

**Objectives:**

The aim is to place the students in various communication situations in French that correspond to social and professional contexts. They learn to express their ideas simply and coherently and are able to understand selective authentic French texts written in everyday language. These texts usually discuss subjects of cultural nature. Radio and television documentaries about the news or subjects linked to the students' specific area of interest are used to practice extracting key information. Students acquire sufficient vocabulary and control of the main grammatical structures to be able to express most of what they want to say relatively easily.

**Course Content:**

**1. Topics**

- French education system
- Employment/Unemployment
- House exchange

The topics were studied through written articles, audio listening and television coverage. Students were also asked to do oral presentations on the above mentioned topics.

**2. Grammar**

- Future perfect
- Nominalization

**3. Types of writing**

- Article for magazine
- Writing/ Responding to queries on forum discussion platforms

## **Description of Core Electives**

**Course Code:** CE 3250  
**Course Name:** Advanced Structural Analysis  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6

**Course Content:**

**Module I: Introduction to Matrix Analysis of Structures**

Introduction to matrix methods of analysis, static and kinematic indeterminacy, degrees of freedom-coordinate system, element stiffness matrix, member stiffness matrix, Transformation of coordinates-element stiffness matrix-and load vector-local and global coordinates, Introduction to flexibility method

**Module II: Analysis of Beam and Plane Truss**

Formulation of element stiffness matrix, assembly, load vector for beam and truss, member end actions and displacements

**Module III: Analysis of Plane Frame**

Formulation of element stiffness matrix, assembly, load vector for plane frames, member end actions and displacements

**Module IV: Introduction to Seismic analysis of structures**

IS 1893:2016 Guidelines for Seismic Analysis of structures, Equivalent static method for frame analysis-Base shear and storey shear, Response spectrum analysis, modal mass, modal participation factors, modal combination rules using absolute sum, SRSS and CQC method.

**Module V: Introduction to Wind analysis of structures**

IS 875-Part III: 2015 Guidelines for Wind Analysis of structures, Basic and Design Wind Speed, Various factors for wind speed, Wind Pressure and Forces, Static analysis for Wind loads

**TEXTBOOKS:**

· Advanced Structural Analysis by Devdas Menon, Narosa Publishing House, Reprint Edition, 2019

· Matrix Analysis of Structures by Asslam Kassimali, Brooks/ Cole Publishing Co., USA 1999.

· Earthquake Resistant Design of Structures by Agarwal, P. and Shrikhande, M., Prentice-Hall of India, 2006

#### REFERENCE BOOKS:

· Matrix Analysis of Framed Structures by William, W. & Gere J.M., CBS Publishers & Distributers, 1986.

· IS 1893:2016- S 1893 (Part 1): 2016. Indian Standard. Criteria for Earthquake Resistant Design. Of Structures. Part 1 General Provisions And Buildings

· IS 875: Part 3: 2015. Design Loads (Other than Earthquake) for Buildings and Structures - Code of Practice Part 3 Wind Loads (Third Revision)

**Course Code:** CE 3251  
**Course Name:** Advanced Concrete Technology  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6

## **Course Content**

### **Module 1: Hydration of Cements and Aggregates**

Portland Cement: Chemical composition; Hydration of cement compounds; Pores in hydrated cement paste;

Types of cements; Reactivity and filler effect of pozzolana;

Aggregate: Influence of size, shape and surface texture of aggregate; Interfacial transition zone; Grading of Aggregate; Particle packing using EMMA\* software.

### **Module 2: Green State Characteristics**

Green State Characteristics: Segregation and bleeding; plastic shrinkage; workability, pumpability and flowability of concrete; concreting in hot and cold weather;

Use of chemical admixtures in enhancing the properties of concrete.

### **Module 3: Microstructure, Strength and Durability**

Microstructure of concrete: Microstructure of hydrated cement paste, aggregate and interfacial transition zone from SEM; Microstructure of Pore space from SEM and MIP. Strength of Concrete;

Durability of concrete: Water permeability, Carbonation and Sulphate attack; Corrosion of steel in concrete

### **Module 4: Fiber-reinforced Concrete**

Fiber Reinforced Concrete (FRC): Types of fibers and their properties; Effect of fiber orientation; Mechanics of fiber pull-out (fiber-matrix interaction); Constitutive response; Influence on workability; Design FRC mixes; Mechanical performance of FRC.

Fiber Reinforced Plastic (FRP) as structural repairs: types; mechanics of load-transfer;

### **Module 5: 3D printable Concrete**

Brief Introduction to additive manufacturing: FDM, powder bed and Inkjet printers; Bio-mimicking; structural optimization;

Design mix for concrete 3D printing: Requirements; Rheology of fresh concrete; Thixotropic nature of concrete; Hardened properties; Influence of print parameters;

**Text Books:**

1. Neville, A. M., 'Properties of Concrete,' Pitman Publishing, Inc., MA, 1981
2. Mehta, P. K., and Monteiro, P. J. M., 'Concrete: Microstructure, Properties, and Materials,' Fourth Edition (Indian Edition), McGraw Hill, 2014.
3. Singh, H. (2016). Steel fiber reinforced concrete: behavior, modelling and design. Springer.
4. Relevant research papers in the areas of FRC and 3D printing.

**Course Code:** CE 4152  
**Course Name:** Dynamics of structures  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 7

**UNIT I : Theory of vibrations:** Introduction - Elements of vibratory system, Degrees of Freedom, Continuous System - Lumped mass idealization - Oscillatory motion, Simple Harmonic motion, Vectorial representation of S.H.M, Free vibrations of single degree of freedom system - undamped and damped vibrations, critical damping, Logarithmic decrement, Forced vibration of SDOF systems, Harmonic excitation, Vibration Isolation, Dynamic magnification factor, Phase angle.

**UNIT II : Introduction to Structural Dynamics :** Fundamental objectives of dynamic analysis, Types of prescribed loading - Methods of discretization - Formulation of equations of motion by different methods, Direct equilibration using Newton's law of motion / D'Alembert's principle, Principle of virtual work and Hamilton principle.

Single Degree of Freedom Systems : Formulation and solution of the equation of motion, Free vibration response, Response to Harmonic, Periodic, Impulsive and general dynamic loadings - Duhamel integral.

**UNIT III : Multi Degree of Freedom Systems :** Selection of the degrees of Freedom, Evaluation of structural property matrices, Formulation of the MDOF equations of motion, Undamped free vibrations, Solutions of Eigen value problem for natural frequencies and mode shapes, Analysis of Dynamic response, Normal co-ordinates, Uncoupled equations of motion, Orthogonal properties of normal modes, Mode superposition procedure.

**UNIT IV : Practical Vibration Analysis:** Introduction to Stodola method, Fundamental mode analysis, Analysis of second and higher modes, Holzer method, Basic procedure.

**Continuous Systems:** Introduction, Flexural vibrations of beams - Elementary case – Derivation of governing differential equation of motion - Analysis of undamped free vibrations of beams in flexure - Natural frequencies and mode-shapes of simple beams with different end conditions - Principles of application to continuous beams.

**UNIT V: Introduction to Earthquake Analysis:** Excitation by rigid base translation, Lumped mass approach, SDOF and MDOF systems, Theory of Response Spectrum Method, analysis for obtaining response of multi storeyed buildings.

**References:**

1. "Dynamics of structures" by Anil K Chopra
2. "Structural Dynamics" by Clough & Penzin
3. "Theory of Vibrations" by Thompson
4. "Elements of vibration analysis" by Leonard Mirovitch
5. "Structural dynamics" by Madhujit Mukhopadyay



**Course Code:** CE 4153  
**Course Name:** Prestressed Concrete  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 7

## **Course Content**

### Module-I

Introduction: Historic development- General principles of prestressing pretensioning and

post tensioning- Advantages and limitations of Prestressed concrete- General principles of

PSC- Classification and types of prestressing- Materials- high strength concrete and high

tensile steel their characteristics.

### MODULE - II

Methods and Systems of prestressing: Pretensioning and Post tensioning methods and systems of prestressing

Losses of Prestress: Loss of prestress in pretensioned and post-tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, slip in anchorage, frictional losses IS 1343- Amd1:2019 code provisions

### MODULE - III

Flexure: Analysis of sections for flexure- beams prestressed with straight, concentric, eccentric, bent and parabolic tendons- stress diagrams- Elastic design of PSC slabs and beams of rectangular and I sections- Kern line – Cable profile and cable layout.

Shear: General Considerations- Principal tension and compression- Improving shear resistance of concrete by horizontal and vertical prestressing and by using inclined or parabolic cables- Analysis of rectangular and I beams for shear – Design of shear reinforcements- IS Code provisions.

### MODULE - IV

Transfer of Prestress in Pretensioned Members : Transmission of prestressing force by bond – Transmission length – Flexural bond stresses – IS code provisions – Anchorage zone stresses in post tensioned members – stress distribution in End block Anchorage zone reinforcement- IS 1343 code Provisions

## MODULE - V

Composite Beams: Different Types- Propped and Unpropped- stress distribution- Differential shrinkage- Analysis of composite beams- General design considerations.

Deflections: Importance of control of deflections- Factors influencing deflections – Short term deflections of uncracked beams- prediction of long time deflections- IS code requirements.

## TEXTBOOKS:

1. Prestressed concrete by Krishna Raju, Tata Mc Graw Hill Book – Co. New Delhi.
2. Design of prestress concrete structures by T.Y. Lin and Burn, John Wiley, New York.

## REFERENCES and CODE BOOKS

1. Prestressed concrete by S. Ramamrutham Dhanpat Rai & Sons, Delhi.
2. Prestressed Concrete by N. Rajagopalan Narosa Publishing House
3. IS 1343 Amd. 1 : 2019- PRESTRESSED CONCRETE — CODE OF PRACTICE

**Course Code:** CE 4254  
**Course Name:** Introduction to Structural Health Monitoring  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 8

**Course Content:**

**Module 1.**

An Overview of Structural Health Monitoring, Need for Structural and Performance Health Monitoring, Structural Health Monitoring versus Non Destructive Evaluation, Passive and active SHM, Type of sensors for SHM, An Overview of Smart Materials.

**Module 2.**

Piezoelectricity and Piezoelectric Materials, Electromechanical Coupling in Piezoelectric Devices, Physical Basis for Electromechanical Coupling in Piezoelectric Materials, Constitutive Equations for Linear Piezoelectric Material. Common Operating Modes of a Piezoelectric Transducer.

**Module 3.**

Non Destructive Testing of Concrete Structures, SHM in civil engineering, Different types of SHM techniques, Vibration based techniques, Electro-Mechanical Impedance Technique for civil engineering applications, Impedance Models for Structural Health Monitoring Using Piezo-Impedance Transducers. Data Acquisition and processing.

**Module 4.**

Capacitive Methods for SHM in civil engineering, Data Acquisition and processing, Case studies in civil engineering.

**Reference:**

Adams Douglas E., 2007, Health Monitoring of Structural Materials and Components: Methods with Applications, John Wiley & Sons Inc.

Zhongqing Su, Lin Ye, Ye Lu, Guided Lamb waves for identification of damage in composite structures: A review, Journal of Sound and Vibration, 2006.

**Course Code:** CE 4255  
**Course Name:** Introduction to Finite Element Analysis  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 8

**Course Content:**

**Module 1: Introduction:** Brief history of the finite element method (FEM) – Overview of finite element (FE) modeling: Representation of system as assemblage of elements; discretization; calculation of element properties; assembly of elements; formulation of system equations from element equations; solution of system equations using basic matrix algebra – Examples of applications in industry and research.

**Module 2: Mathematical preliminaries for finite element analysis:** Coordinate systems – Initial value, boundary value and eigenvalue problems – Integral identities – Linear and bilinear functionals – Introduction to calculus of variations – Integral formulations – Variational methods.

**Module 3: One-dimensional elements:** Introduction – Spring element – Derivation of stiffness matrix for spring element – Spring assemblage – Assembly of total stiffness matrix by superposition – Boundary conditions – Derivation of spring element equations using potential energy approach – Bar element – Derivation of stiffness matrix for bar element in local coordinates – Selection of approximation functions for displacements – Transformation of vectors in two dimensions – Global stiffness matrix for bar element – Derivation of bar element equations using potential energy approach.

**Module 4: Basic two-dimensional elements:** Introduction – Interpolation – Shape functions – Element matrices – Linear triangle: interpolation functions, element matrices and element defects – Quadratic triangle: interpolation functions – Bilinear rectangle: interpolation functions, element matrices and element defects – Quadratic rectangle: interpolation functions.

**Module 5: Weighted residual methods and isoparametric elements:** Galerkin method – Introduction and one-dimensional bar example – Other weighted residual methods – One-dimensional finite element form of the Galerkin method – Introduction to the concept of isoparametric elements.

**Recommended textbooks / references:**

1. R.D. Cook, D.S. Malkus, M.E. Plesha, R.J. Witt, *Concepts and Applications of Finite Element Analysis*, 4<sup>th</sup> edition, Wiley, 2003.
2. J.N. Reddy, *An Introduction to the Finite Element Method*, 3<sup>rd</sup> edition, McGraw Hill Education, 2006.
3. D.L. Logan, *A First Course in the Finite Element Method*, 4<sup>th</sup> edition, Cengage Learning, 2007.
4. P. Seshu, *Textbook of Finite Element Analysis*, PHI Learning, 2003.

**Course Code:** CE 3256  
**Course Name:** TE - II (Railways, Airports & Harbour Engineering)  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6

**Course Content:**

**Module 1:** History and general features of Indian railways – Gauges - Elements of permanent way – Rails, sleepers, ballast, rail fixtures and fastenings – types and functions - Resistances to traction and stresses in track – coning of wheels – creep, wear and defects in rails – track alignment

**Module 2:** Geometric design of railway track – Horizontal curves and superelevation – equilibrium cant and cant deficiency – vertical curves – gradients and grade compensation – widening of gauge on curves - Points and crossings – Turn out - Railway stations and yards - Signaling and interlocking

**Module 3:** History of Aviation – Air transportation in India – Regional planning - Aircraft characteristics – Airport classifications - Location and planning of airport elements – terminal area, obstructions, zoning law, approach zone, turning zone, airport capacity – Airport size and site selection.

**Module 4:** Runway configurations – wind rose and orientation of runway - runway length- Corrections to runway length - runway geometric design – elements of taxiway, apron and hangar – aircraft parking configuration and parking system - Air traffic control – Objectives - Airport markings and lighting – airport drainage

**Module 5:** Water transportation- Harbours - Classification - Site selection- Harbour layout - Ports - Classification of ports - Coastal structures: Piers, Breakwaters, Wharves, Jetties, Quays, Fenders - Docks – classification – working principle – Repair docks - Port amenities: Ferry, transit sheds, ware houses - Navigational facilities – buoys, beacons, light house – Harbour maintenance: dredging.

*Guest Lectures from the industry experts will be added.*

**Text Books:**

5. Transportation Engineering Vol. 1 and 2 by Vazirani and Chandola,
6. Planning & Design of Airports by Robrt Horonjeff, Francis McKelvey; TataMcGrawhill
7. Harbour, Dock & Tunnel Engineering- R.Srinivasan; Charotar Publishers, Ahmedabad.

**References**

1. Railway Engineering (2012) - Rangwala
2. Airport Planning and Design- S.K.Khanna, M.G.Arora & S.S.Jain; NemChand & Bros, Roorkee, India
3. Dock & Harbour Engineering- H.P.Oza & G.H.Oza; Charotar Publishers, Ahmedabad.
4. Harbour, Dock & Tunnel Engineering- R.Srinivasan; Charotar Publishers, Ahmedabad.

**Course Code:** CE 3257  
**Course Name:** Urban Transportation Planning  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6

**Course Content:**

**UNIT I: Transport Planning Process**

Scope – interdependence of land use and traffic – systems approach to transport planning – Transport surveys – definition of study area – zoning survey - types and methods – inventory on transport facilities - inventory of land use and economic activities.

**UNIT II: Trip Generation**

Factors governing trip generation and attraction rates – multiple linear regression analysis – category analysis – critical appraisal of techniques.

**UNIT III: Trip Distribution Methods**

Presentation of trip distribution data - PA matrix to OD matrix – Growth factor methods - gravity model and its calibration – opportunity model

**UNIT IV: Modal split analysis**

Influencing factors – Earlier modal split models: Trip end type and trip interchange type – limitations – Disaggregate mode choice model – Logit model - binary choice situations – multinomial logit model – model calibration

**UNIT V: Route assignment**

Description of highway network – route choice behaviour – shortest path algorithm - assignment techniques – all nothing assignment – multi path assignment – capacity restrained assignment – diversion curves

**Text Books:**

Hutchinson, B.G. (1974). Principles of Urban Transport Systems Planning. McGraw Hill Book Company, New York.

**Reference Books:**

Kadiyali, LR (1987), Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi.

NPTEL videos on Urban Transportation Planning, Dr. V. Tamizh Arasan, IIT Madras

Paul.H.Wright (1995), Transportation Engineering – Planning & Design, John Wiley & Sons, New York.

John W Dickey (1995), Metropolitan Transportation Planning, Tata McGraw-Hill publishing company Ltd, New Delhi.

Papacostas, C.S., and Prevedouros, P.D. (2002). Transportation Engineering and Planning. 3rd Edition, Prentice - Hall of India Pvt Ltd.



**Course Code:** CE 4158  
**Course Name:** Transport & Environment  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 7

**Course Content:**

**Module I: Introduction**

Importance of transportation-related environmental problems in the global, national, regional and local context, Global warming & climate change

**Module II: Air Pollution**

Pollutants: Gases, Particles; Pollutant Sources: Motor Vehicles Emissions, Train Emissions, Shipping Emissions, Aircraft Emissions; Measurement and Data Analysis: Concentration Measurement of Gases, Concentration Measurement of Particles, Analysis of an Air-quality Data Set; Mitigation and Effects of Air Pollution: The Role of Vegetation, Effects on Humans and Animals, Effects on Plants, Soil and Groundwater, Effects on Materials; Control of Emission: EU legislation, UK legislation, US legislation, Legislation in Asian Regions

**Module III: Measures to mitigate traffic emissions**

The relative cost-effectiveness of emissions technology vs. non-technological strategies; the potential for changing travel behavior to promote environmental quality; parking, road congestion pricing, and transit options; the congestion-air quality nexus; energy consumption implications; and what we mean by sustainable transportation.

**Module IV: Noise Pollution**

Noise: Introduction to Acoustics, The nature of environmental noise; Noise Sources: Motor Vehicles Emissions, Train Emissions, Aircraft Emissions; Measurement, Prediction, Propagation and Control of Noise (Considering German, British and American Guides): Noise Measurement; Prediction, Propagation and Control of Railway Noise; Prediction, Propagation and Control of Airport Noise; Effects of Noise on Humans and Animals

**Module V: Environmental Impact assesment**

Impacts of transportation projects; Case studies

**Text Books:**

Environmental Science and Engineering, by J. Glynn and Gary W. Hein Ke – Prentice Hall Publishers



**Course Code:** CE4159  
**Course Name:** Traffic Engineering & Management  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

**Module 1 - Traffic stream characteristics**

Introduction to traffic engineering, Road user & Vehicle characteristics, Fundamental parameters and relations of traffic flow, Traffic stream models, Moving observer method, Traffic measurement procedures

**Module 2 - Traffic intersection control:**

Principles of traffic control, Traffic signs and road markings, Uncontrolled intersection, Channelization, Traffic rotary, Grade separated intersection.

**Module 3 - Traffic signal design:**

Elements of traffic signal, Design principles of a traffic signal, Evaluation of a traffic signal, Coordinated traffic signal, Vehicle actuated signals and area traffic control.

**Module 4 - Specialised traffic studies:**

Parking Studies, Accident Studies, Congestion studies, Toll operation, Pedestrian studies, Fuel consumption and emission studies.

**Module 5 – Intelligent transportation systems:**

Introduction, ITS user services, ITS Architecture, ITS planning and evaluation.

**Text Books:**

- Roess, RP., McShane, WR. and Prassas, ES. (1998), Traffic Engineering, Prentice Hall.

**Reference Books:**

- Kadiyali, L.R. (1987), Traffic Engineering and Transportation Planning, Khanna.
- May, A. D. (1990), Fundamentals of Traffic Flow, Prentice Hall.
- Papacostas, C. S. (1987), Fundamentals of Transportation Engineering, Prentice Hall.
- Khanna, S. K. and Justo, C. E. G. (1991), Highway Engineering, Nemchand.
- Pingnataro, G. J. (1970), Principles of Traffic Engineering, Mc Graw - Hill.

**Course Code:** CE 4260  
**Course Name:** Pavement Analysis & Design  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 8

**Course Content:**

**Module 1: Introduction to pavement design**

Types of pavement – Flexible, rigid, composite; Factors affecting design of pavements – Wheel loads, Material properties, Environmental and other factors; Different types of pavement performance criteria; Different pavement design approaches; Traffic Considerations in Pavement Design - Axle configurations, Contact shapes and contact stress distributions, Concept of standard axle load, Vehicle damage factor, Axle load surveys.

**Module 2: Analysis & design of flexible pavement**

Stresses in flexible pavement- layered systems concept, one layer system, two layer system, Design of flexible pavements- IRC: 37, AASHTO methods.

**Module 3: Analysis & design of rigid pavement**

Analysis of wheel load stresses, curling/warping stresses due to temperature differential, critical stress combinations. Methods of design of concrete pavements- IRC: 58, AASHTO, PCA methods.

**Module 4: Pavement evaluation techniques**

Functional and structural evaluation of pavements, concept of roughness, international roughness index, measurement of roughness using different types of equipment, structural evaluation of in-service pavements using Benkelman beam and falling weight deflectometer methods.

**Module 5: Pavement overlay design methods:**

Overlay design as per Indian Roads Congress guidelines (IRC:81), Overlay design as per AASHTO-1993 guidelines.

**Text Books:**

1. Yang H Huang “Pavement Analysis and Design”, Prentice Hall.
2. EJ Yoder and MW Witzak, “Principles of Pavement Design”, John Wiley & Sons.

**Standard codes:**

1. AASHTO Guide for Design of Pavement Structures”, American Association of State Highway and Transport Officials.
2. IRC:37-2001 “Guidelines for the Design of Flexible Pavements”, Indian Roads Congress, New Delhi.
3. IRC:58-2002, “Guidelines for the Design of Plain Jointed Rigid Pavements for Highways”, Indian Roads Congress, New Delhi.
4. IRC:81-1997, “Guidelines for Strengthening of Flexible Road Pavements using Benkelman beam deflection techniques”, Indian Roads Congress, New Delhi.

**Course Code:** CE 4261  
**Course Name:** Intelligent Transportation Systems  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

**UNIT I: Fundamentals of ITS**

Introduction to Intelligent transportation systems – Definition – objectives – historical background – benefits of ITS

**UNIT II: Telecommunications and data requirements of ITS**

Importance of telecommunications in the ITS – Information management – Traffic Management Centres (TMC) – Application of sensors to traffic management – Traffic flow sensor technologies – ITS data collection techniques: Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, Video data collection

**UNIT III: ITS user services**

Introduction – Travel and traffic management – Public transportation operations – Electronic payment – Commercial vehicle operations – Advanced vehicle control and safety systems – Emergency management – Information management – Maintenance and construction management

**UNIT IV: ITS architecture and evaluation**

National and Regional ITS architecture – ITS models and evaluation methods – Planning and human factor issues for ITS – ITS and safety – ITS and security - ITS planning – ITS standards and evaluation – Traffic simulation for evaluation of ITS

**UNIT V: ITS applications**

Automated highway systems – Vehicles in platoons – Integration of automated highway systems – uses of V2I and V2V interaction - ITS programs in the world – Overview of ITS implementations in developed countries – ITS in developing countries – Case studies

**Text Books:**

Fundamentals of Intelligent transportation systems planning By Mashrur A. Chowdhury, Adel Wadid Sadek.

Lawrence A. Klein, Sensor technologies and Data requirements of ITS.

ITS Hand Book 2000: *Recommendations for World Road Association (PIARC)* by Kan Paul Chen, John Miles.

Sussman, J. M., *Perspective on ITS*, Artech House Publishers, 2005.

National ITS Architecture Documentation, US Department of Transportation, 2007.

**Course Code:** CE 4162  
**Course Name:** Geosynthetics and Reinforced Soil structures  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 7  
**Course Content:**

Introduction: Historical background of reinforced soil, Principles of reinforced soil through Mohr circle analysis.

Different types of geosynthetics: Types of geosynthetics like geotextiles, geogrids, geonets, geocells, geo-composites, their manufacturing methods. Testing methods for geosynthetics: Techniques for testing of different index properties, strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage, extrapolation of long term strength properties from short term tests.

Reinforced Soil retaining walls: Different types of walls like wrap-around walls, full-height panel walls, discrete-facing panel walls, modular block walls Design methods as per BS-8006 and FHWA methods Construction methods for reinforced soil retaining walls.

Reinforced soil slopes: Basal reinforcement for construction on soft clay soils, construction of steep slopes with reinforcement layers on competent soils, Different slope stability analysis methods like planar wedge method, bi-linear wedge method, circular slip methods. Erosion control on slopes using geosynthetics.

Applications in foundations: Binquet and Lee's approach for analysis of foundations with reinforcement layers. Drainage and filtration applications of geosynthetics: Different filtration requirements, filtration in different types of soils and criteria for selection of geotextiles, estimation of flow of water in retaining walls, pavements, etc. and selection of geosynthetics.

Pavement application: Geosynthetics for separation and reinforcement in flexible pavements, design by Giroud-Noiray approach, reflection cracking and control using geosynthetics. Use of geosynthetics for construction of heavy container yards and railway lines.

Construction of landfills using geosynthetics: Different components of modern landfills, collection techniques for leachate, application of different geosynthetics like geonets, geotextiles for drainage in landfills, use of geomembranes and Geosynthetic Clay Liner (GCL) as barriers.

## REFERENCES

1. Koerner, R.M. "Designing with Geosynthetics", Prentice Hall, New Jersey, USA, 4th edition, 1999.
2. Jewell, R.A., "Soil Reinforcement with Geotextiles", Special Publication No. 123, CIRIA, Thomas Telford. London, UK, 1996.
3. Geosynthetics - New Horizons, Eds. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana, Asian Books Private Ltd., New Delhi, 2004.
4. Design guidelines from FHWA, BS and other codal organizations.

**Course Code:** CE 4163  
**Course Name:** Advanced Foundation Engineering  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 7

**Course Content:**

- Subsurface Exploration, Shallow Foundations - Ultimate bearing capacity, Safe bearing pressure, settlement analysis.
- Design of Combined and Raft foundations, Design of Retaining walls, Sheet pile walls, Braced cuts, Pile foundations, Drilled piers and Caissons.
- Machine Foundations, Concept of reinforced earth

**Text/Reference Books:**

1. Joseph Bowles, "Foundation Analysis and Design", McGraw-Hill Book Company.
2. Braja M. Das, "Principles of Foundation engineering", PWS Publishing Company.
3. V.N.S. Murthy, "Advanced Foundation Engineering", CBS Publishers and Distributors

**Course Code:** CE 4163  
**Course Name:** Advanced Foundation Engineering  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 7

**Course Content:**

- Subsurface Exploration, Shallow Foundations - Ultimate bearing capacity, Safe bearing pressure, settlement analysis.
- Design of Combined and Raft foundations, Design of Retaining walls, Sheet pile walls, Braced cuts, Pile foundations, Drilled piers and Caissons.
- Machine Foundations, Concept of reinforced earth

**Text/Reference Books:**

4. Joseph Bowles, "Foundation Analysis and Design", McGraw-Hill Book Company.
5. Braja M. Das, "Principles of Foundation engineering", PWS Publishing Company.
6. V.N.S. Murthy, "Advanced Foundation Engineering", CBS Publishers and Distributors

**Course Code:** CE 4264  
**Course Name:** Ground Improvement Techniques  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 8

### **Course Content**

#### **UNIT I : PROBLEMATIC SOIL AND IMPROVEMENT TECHNIQUES**

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

#### **UNIT II : DEWATERING**

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

#### **UNIT III : INSITU TREATMENT OF COHESIONLESS AND COHESIVE SOILS**

Insitu densification of cohesion-less soils and consolidation of cohesive soils: Dynamic compaction Vibroflotation, Sand compaction piles and deep compaction. Consolidation: Preloading with sand drains, and fabric drains, Stone columns and Lime piles-installation techniques – simple design – relative merits of above methods and their limitations.

#### **UNIT IV : EARTH REINFORCEMENT**

Concept of reinforcement – Types of reinforcement material – Reinforced earth wall – Mechanism – simple design – applications of reinforced earth. Role of Geotextiles in filtration, drainage, separation, road works and containment.

#### **UNIT V : GROUT TECHNIQUES**

Types of grouts – Grouting equipments and machinery – injection methods – Grout monitoring – stabilization with cement, lime and chemicals – stabilization of expansive soil.

### **Text/Reference Books:**

1. Raju P. P. *Ground Improvement Techniques*, Laxmi Publications.
2. Moseley M. P. and Kirsch K. *Ground Improvement*, Spon Press.
3. Das B. M. *Principles of Foundation Engineering*, Cengage Learning.
4. Indraratna B. and Chu J. J. *Ground Improvement: Case Histories*, Elsevier.
5. Raison C. A. *Ground and Soil Improvement*, Thomas Telford.
6. Koerner R. M. *Designing with Geosynthetics*, Pearson.

**Course Code:** CE 4265  
**Course Name:** Soil – Structure Interaction  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 8

### **Course content**

Introduction to soil foundation interaction problems, soil behaviour, foundation behaviour, interface behaviour, concept of subgrade modulus, effects/parameters influencing subgrade modulus soil foundation interaction analysis, Winkler, elastic continuum, two parameter elastic model, Elastic Plastic behaviour, time dependent behaviour, elastic analysis of single pile, theoretical solutions for settlement and load distributions, analysis of pile group, interaction analysis, Load deflection prediction for laterally loaded piles, other applications.

### **Text/Reference Books:**

1. Selvadurai A. P. S. *Elastic analysis of soil foundation interaction*, Elsevier Science.
2. Davis R. O. and Selvadurai A. P. S. *Plasticity and Geomechanics*, Cambridge University Press.
3. Davis R. O. and Selvadurai A. P. S. *Elasticity and Geomechanics*, Cambridge University Press.
4. Poulos H. G. and Davis E. H. *Pile Foundation Analysis and Design*, Wiley
5. Bull J. W. *Soil structure interaction: numerical analysis and modelling*, Spon.



## **Description of Open Electives (Departmental)**

**Course Code:** CE 4066  
**Course Name:** Pavement Material Characterization & Construction  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

## **Course Content**

### **Module 1: Sub- grade Soil Characterization**

Properties of sub-grade layers, different types of soils, soil classification, Index and other basic properties of soil; A critical look at the different laboratory and in-situ procedures for evaluating the mechanical properties of soils viz. SPT, DCPT, CPT, CBR, Plate Load test & resilient modulus; Suitability of different type of soil for the construction of highway embankments and pavement layers; Field compaction and control. Dynamic properties of soil: FWD test.

### **Module 2: Aggregate Characterization**

Origin, Classification, Types of aggregates; Sampling of aggregates; Mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; Proportioning and Blending of aggregates: Super pave gradation, Fuller and Thompson's Equation, 0.45 power maximum density graph; Use of locally available materials in lieu of aggregates.

### **Module 3: Bitumen and Bituminous Concrete Mix Characterization**

Bitumen sources and manufacturing, Chemistry of bitumen, bitumen structure, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, Modified bitumen: Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Introduction to emulsified bitumen and its characterization; Modified Marshall's specifications.

### **Module 4: Pavement construction equipment**

Different types of excavators, graders, soil compactors / rollers, pavers and other equipment for construction of different pavement layers – their uses and choice, Problem on equipment usage charges; Pre-construction surveys and marking on ground - Specifications and steps for the construction of road formation in embankment and cut, construction steps for granular sub-base, quality control tests.

### **Module 5: Pavement construction**

WMM, CRM, WBM; specifications, construction method and quality control tests. Different types of bituminous layers for binder and surface courses; their specifications (as per IRC and MORTH); construction method and quality control tests. Different types of sub-base and base course for cement concrete (CC) pavement and construction method. Construction of cement concrete (PQC) pavements joints quality control during construction. Construction details of interlocking concrete block pavements.

## **Text Books:**

## **Standard codes:**

MoRTH Manual for Construction and Supervision of Bituminous Works- 2013, Indian Roads Congress

MoRTH Manual for Maintenance of Roads- 1989,

Indian Roads Congress IRC: 42-1994, IRC:15-2002, IRC SP :11-1988, , 55-2001, 57-2001,58-2001, IRC 19-1977, 27-1967, 29-1988, 34-1970, 36-1970,48-1972,61-1976, 63-1976, 68-1976, 81-1997,82-1982, 84-1983,93-1985, 94-1986, 95-1987, 98-1997, 105-1988.

**Course Code:** CE 4067  
**Course Name:** Airport Planning and Design  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

## Course Contents

### Module 1

**Airport Planning:** General- Regional Planning- Development of New Airport- Data Required Before Site Selection- Airport Site Selection- Surveys for Site Selection- Drawings to be prepared- Estimation of Future Air Traffic Needs.

### Module II

**Runway Design:** Runway Orientation- Basic Runway Length- Corrections for Elevation, Temperature and Gradient- Airport Classification- Runway Geometric Design- Airport Capacity- Runway Configurations- Runway Intersection Design.

### Module III:

**Structural Design Of Airport Pavements:** Introduction- Various Design Factors- Design Methods for Flexible Pavement- Design Methods for Rigid Pavement- LCN System of Pavement Design- Joints in Cement Concrete Pavement- Airport Pavement Overlays- Design of an Overlay.

### Module- IV:

**Visual Aids:** General- Airport Marking- Airport Lighting.

### Module- V:

**Airport Grading And Drainage:** General- Computation of Earthwork- Airport Drainage- Special Characteristics and Requirements of Airport Drainage- Design Data- Surface Drainage Design- Subsurface Drainage Design.

## REFERENCES:

1. Airport Planning and Designing by S.K. Khanna, M. G. Arora.
2. Highway Engineering including Expressways and Airport Engineering by Dr. L. R. Kadyali, Dr. N. B. Lal.
3. Highway Engineering including Airport Pavements by Dr. S. K. Sharma.
4. Transportation Engineering by S. P. Chandola.

**Course Code:** CE 4068  
**Course Name:** Advanced Soil Mechanics  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

1. Introduction: Origin of soil and its types, mineralogy and structure of clay minerals, consolidation: Steady State flow, 2D and 3D seepage, transient flow;
2. Compressibility and rate of consolidation, one, two, and three dimensional consolidation theories; Sand drains;
3. Mohr's circles;
4. Critical state soil mechanics: Critical State Line, Hvorslev Surface, Yield Surfaces: Modified Cam-clay and Original Cam-clay;
5. Elastic and plastic analysis of soil: Constitutive relationships of soil; failure theories. Limit analysis-Upper bound theorems, lower bound theorems, limit equilibrium methods;
6. Soil Stabilization: Classification of stabilizing agents and stabilization processes. Strength improvement characteristic of soft and sensitive clays, Marine clay and waste material.

**Text/Reference Books:**

1. Das B. M. *Advanced Soil Mechanics*, Taylor and Francis.
2. Scott R. F. *Principles of Soil Mechanics*, Addison & Wesley.
3. Davis R. O. and Selvadurai A. P. S. *Elasticity and Geomechanics*, Cambridge University Press.
4. Mitchell J. K. *Fundamentals of Soil Behaviour*, Wiley.
5. Wood D. M. *Soil Behaviour and Critical State Soil Mechanics*, University of Glasgow.
6. Schofield A. N. and Wroth C. P. *Critical State Soil Mechanics*, McGraw-Hill.

**Course Code:** CE4069  
**Course Name:** Environmental Geotechnics  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

Fundamentals of geoenvironmental engineering, multiphase behavior of soil, case histories on geoenvironmental engineering problems, Soil-water-contaminant interaction studies, concepts of unsaturated soil in geoenvironmental engineering, Waste containment system, property evaluation of soil, design practices, Vertical barriers, Contaminant site remediation, some examples of in-situ remediation, Advanced soil characterization for geoenvironmental applications.

**Text/Reference Books:**

1. Rowe R.K., "Geotechnical and Geoenvironmental Engineering Handbook" Kluwer Academic Publications, London, 2000.
2. Reddi L.N. and Inyang, H. I., "Geoenvironmental Engineering, Principles and Applications" Marcel Dekker Inc. New York, 2000.
3. Yong, R. N., "Geoenvironmental Engineering, Contaminated Soils, Pollutant Fate, and Mitigation" CRC Press, New York, 2001.
4. Sharma H.D. and Reddy K.R., "Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies" John Wiley & Sons, Inc., USA, 2004.
5. Fredlund D.G. and Rahardjo, H., "Soil Mechanics for Unsaturated Soils" Wiley-Interscience, USA, 1993.
6. Mitchell, J. K., "Fundamentals of Soil Behavior" Wiley, 2005.
7. Hillel D., "Introduction to Environmental Soil Physics" Academic Press, New York, 2003.

**Course Code:** CE 4070  
**Course Name:** Geotechnical Earthquake Engineering  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

**UNIT I : SEISMOLOGY AND EARTHQUAKES**

Internal Structure of the Earth – Continental Drift and Plate Tectonics – Faults – Elastic rebound theory – Different sources of Seismic Activity – Geometric Notation – Location of Earthquakes – Size of Earthquakes.

**UNIT II : DYNAMIC PROPERTIES OF SOILS**

Measurement of Dynamic Properties of soils – Field Tests – Low strain – Seismic Reflection – Seismic Refraction – Horizontal layering – Steady State Vibration – Spectral analysis of surface wave – Seismic cross hole – Down Hole – Up hole – tests – Laboratory tests – Resonance Column Test – Bender Element – Cyclic Tri-axial test.

**UNIT III : SEISMIC HAZARD ANALYSIS**

Identification and Evaluation of Earthquake Sources – Geologic Evidence – Tectonic Evidence – Historical Seismicity – Instrumental Seismicity – Deterministic Seismic Hazard Analysis – Probabilistic Seismic Hazard Analysis.

**UNIT IV : GROUND RESPONSE ANALYSIS**

Ground Response Analysis – One Dimensional Linear – Evaluation of Transfer Function – Uniform undamped soil on rigid rock – Uniform damped soil on Rigid Rock – Uniform damped soil on elastic rock – layered damped soil on elastic rock – Equivalent linear Approximation – Deconvolution.

**UNIT V : LIQUEFACTION ANALYSIS**

Liquefaction – Flow liquefaction – Cyclic Mobility – Evaluation of liquefaction Hazards – Liquefaction Susceptibility – Criteria – Historical Geologic – Compositional – State – Evaluation of Initiation of Liquefaction – Cyclic stress approach – Characterization of Liquefaction Resistance – SPT Test – Various correction factor – Factor of Safety.

**Text/Reference Books:**

1. Kramer S. L. *Geotechnical Earthquake Engineering*, Pearson.
2. Day R. W. *Geotechnical Earthquake Engineering Handbook*, McGraw-Hill.

**Course Code:** CE 4071  
**Course Name:** Risk Assessment and Management in Geotechnical Engineering  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

### **Course content**

Introduction to probabilistic geotechnical engineering, variability measures, random variables, probability mass and density functions, moments of distribution, modelling of uncertainty, engineering judgment, spatial variability of soil, autocovariance functions, functions of random fields, levels of reliability, loads and resistances, reliability methods, first order second moment (FOSM) method, Hasofer-Lind approach, Response Surface Method, Monte Carlo simulations.

- 1 Introduction
- 2 Models
- 3 Geological risks
- 4 An engineer's assessment of risk of slope stability
- 5 Probabilistic slope instability analyses
- 6 Probabilistic dam safety evaluations
- 7 The importance of engineering judgement

### **Text/Reference Books:**

1. Haldar A. and Mahadevan S. *Probability, Reliability, and Statistical Methods in Engineering Design*, John Wiley.
2. Baecher G. and Christian J. *Reliability and Statistics in Geotechnical Engineering*, John Wiley.
3. Ang A. H. S. and Tang W. H. *Probability Concepts in Engineering Planning and Design: Basic Principles (Vol. I)*, John Wiley.
4. Ang A. H. S. and Tang W. H. *Probability Concepts in Engineering Planning and Design: Decision, Risk, and Reliability (Vol. II)*, John Wiley.
5. Ang A. H. S. and Tang W. H. *Probability Concepts In Engineering: Emphasis On Applications In Civil & Environmental Engineering*, Wiley.
6. Melchers R. E. *Structural Reliability Analysis and Prediction*, John Wiley.
7. Nowak A. S. and Collins K. R. *Reliability of Structures*, CRC Press.
8. Vanmarcke E. *Random Fields: Analysis and Synthesis*, MIT Press.



**Course Code:** CE 4072  
**Course Name:** Rock Mechanics  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

Classification of Rocks and Rock masses, Laboratory and in-situ testing of rock, insitu stresses and their measurement, Analysis and design of underground openings, Failure criteria for rock and rock masses.

Strength and deformability of jointed rock mass, Stability of rock slopes, Foundation on rocks. Methods to improve rock mass responses, numerical modeling of rock and rock masses.

**Text/Reference Books:**

1. Introduction to Rock Mechanics by R.E.Goodman, John Wiley & Sons.
2. Engineering in Rocks for Slopes, Foundation and Tunnels, Editor T.Ramamurthy, Prentice Hall India Pvt. Ltd.
3. Fundamentals of Rock Mechanics, Fourth Edition, by Jaeger, Cook and Zimmerman, Blackwell Publishing.
4. Rock mechanics and the design of structures in rock, L. Obert and Wilbur I. Duvall, John Wiley & Sons, Inc.

**Course Code:** CE 4073  
**Course Name:** Soil Dynamics and Machine Foundations  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

Introduction, vibration theories, analysis of free and forced vibrations using spring dashpot model, single degree of freedom system, multi-degrees of freedom system, application of single and multi-degree of freedom systems, wave propagation in elastic media, laboratory and field evaluation of dynamic soil properties, Design of Machine Foundations.

**Text/Reference Books:**

1. Saran S. *Soil Dynamics and Machine Foundations*, Galgotia.
2. Das B. M. and Ramana G. V. *Principles of Soil Dynamics*, CL-Engineering.
3. Richart F. E., Woods R. D. and Hall J. R. *Vibrations of soils and foundations*, Prentice.
4. Kramer S. L. *Geotechnical Earthquake Engineering*, Prentice.

**Course Code:** CE 4074  
**Course Name:** Introduction to Continuum Mechanics  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

**Module 1: Introduction:** The continuum concept: definition and significance – Vectors and tensors: a brief introduction – Review of vector algebra – Indicial notation and the summation convention – Kronecker delta and permutation symbol – Theory of matrices – Review of vector calculus – Tensors: an introduction – Dyads and dyadics – Nonion form of a second-order tensor – Transformation of components of a tensor – Tensor calculus: an introduction – Eigenvalues and eigenvectors.

**Module 2: Kinematics of continua:** Descriptions of motion – Analysis of deformation – Strain measures – Infinitesimal strain tensor and rotation tensor – Velocity gradient and vorticity tensors – Compatibility equations – Rigid-body motions – Polar decomposition theorem.

**Module 3: Stress measures:** Cauchy stress tensor – Transformation of stress components – Principal stresses – First and second Piola-Kirchhoff stress tensors – Equilibrium equations for small deformations – Objectivity of stress tensors: a brief introduction.

**Module 4: Conservation and balance laws:** Conservation of mass – Material time derivative – Vector and integral identities – Continuity equation in spatial description – Continuity equation in material description – Reynolds transport theorem – Balance of linear and angular momentum – Balance of energy – Entropy inequality.

**Module 5: Constitutive equations:** Introduction – General principles of constitutive theory – Material frame indifference – Restrictions placed by entropy inequality – Elastic materials – Cauchy-elastic materials – Green-elastic or hyperelastic materials – Hookean solids – Generalized Hooke's law – Material symmetry planes – Monoclinic, orthotropic and isotropic materials.

**Recommended textbooks / references:**

1. J.N. Reddy, *An Introduction to Continuum Mechanics*, 2<sup>nd</sup> edition, Cambridge University Press, 2013.
2. W.M. Lai, D. Rubin, E. Krempl, *Introduction to Continuum Mechanics*, 4<sup>th</sup> edition, Butterworth Heinemann, 2009.
3. A.J.M. Spencer, *Continuum Mechanics*, Dover Publications, 2004.

**Course Code:** CE 4075  
**Course Name:** Introduction to Fracture Mechanics  
**Credits:** 3 (3-0-0)  
**Course Position:** Semester 6, 7 or 8

**Course Content:**

**Module 1: Introduction:** Overview of structural failure – Brief history of fracture research – The fracture mechanics approach to design – Energy criterion – Stress intensity approach – Time-dependent crack growth – Damage tolerance – Effect of material properties on fracture – Brief review of dimensional analysis – Buckingham  $\Pi$ -theorem – Dimensional analysis in fracture mechanics.

**Module 2: Linear elastic fracture mechanics:** Introduction – Stress concentration effect of flaws – Griffith energy balance – Energy release rate – Instability – The R curve – Stress analysis of cracks – Stress intensity factor – Relation between stress intensity factor and energy release rate – Crack tip plasticity – K-controlled fracture – Plane strain fracture – Mixed-mode fracture.

**Module 3: Elastic-plastic fracture mechanics:** Introduction – Crack tip opening displacement (CTOD) – The J contour integral concept – Nonlinear energy release rate – J as a path-independent line integral – J as a stress intensity factor – Relationships between J and CTOD – Crack growth resistance curves – Stable and unstable crack growth.

**Module 4: Fracture mechanisms:** Fracture mechanisms in metals – Ductile fracture: void nucleation, void growth and coalescence, ductile crack growth – Cleavage fracture – Ductile-to-brittle transition – Intergranular fracture – Brief introduction to fracture mechanisms in concrete.

**Module 5: Fatigue of metals:** Introduction – Stress cycles – The  $S-N$  curve – Statistical nature of fatigue – Theories of fatigue – Effect of stress concentration on fatigue – Size effect – Effect of mean stress on fatigue.

**Recommended textbooks / references:**

1. T.L. Anderson, *Fracture Mechanics: Fundamentals and Applications*, 3<sup>rd</sup> edition, CRC Press, Taylor and Francis Group, 2005.
2. T. Kundu, *Fundamentals of Fracture Mechanics*, CRC Press, Taylor and Francis Group, 2008.
3. P. Kumar, *Elements of Fracture Mechanics*, Tata McGraw-Hill, 2009.
4. G.E. Dieter, *Mechanical Metallurgy*, 3<sup>rd</sup> edition, McGraw Hill Education, 2017.

**Course Code:** CE 4076  
**Course Name:** Earthquake Engineering  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6,7 or 8

### **Unit-I**

**Introduction to Earthquake Engineering:** Engineering Seismology, Earthquake phenomenon, Causes and effects of earthquakes, Failures of structures in past earthquakes and lessons learnt, Faults Structure of earth, Plate Tectonics, Elastic Rebound Theory, Earthquake Terminology, Source, Focus, Epicenter, Earthquake size. Magnitude and intensity of earthquakes, Classification of earthquakes, Seismic waves, Seismic zones, Seismic Zoning Map of India, Seismograms and Accelerograms.

### **Unit-II**

**Codal Design Provisions:** Review of the latest Indian seismic code IS:1893 –2002 (Part-I) provisions for buildings, Earthquake design philosophy, Assumptions, Analysis of multi storied building by seismic coefficient and response spectrum methods, Displacements and drift requirements, Provisions for torsion.

**Codal Detailing Provisions:** Review of the latest Indian codes IS: 4326 and IS: 13920 Provisions for ductile detailing of R.C buildings, Beam, column and joints.

### **Unit-III**

**Aseismic Planning:** Plan Configurations, Torsion Irregularities, Re-entrant corners, Non parallel systems, Diaphragm Discontinuity, Vertical Discontinuities in load path, Irregularity in strength and stiffness, Mass Irregularities, Vertical Geometric Irregularity, Proximity of Adjacent Buildings.

### **Unit-IV**

**Earthquake Resistant design of masonry building:** Identification of damages and no-damages in masonry building from past earthquakes, lesson learnt, Elastic properties of structural masonry, lateral load analysis of masonry building, Design of masonry building.

### **Unit-V**

**Innovative Strategies in Earthquake Engineering: Introduction to P-BSD, Energy Equations, concepts of damage control structures**

### **References:**

1. Elements of earthquake engineering Jaikrishna and Chandrasekaran.
2. Earthquake Resistant Design of Structures - Pankaj Agarwal and Manish Shrikhande
3. Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering - Yousef Bozorgnia, Vitelmo V. Bertero

**Course Code:** CE 4077  
**Course Name:** Sanitary Engineering and Design  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

### **Unit -I: Sanitation**

Sewage Characteristics - sewer sewage and sewerage -methods of collection - conservancy system, water carriage system - classification of sewerage systems - quantity of sanitary sewage - fluctuation in sewage flow - design of flow of sewage for separate, storm and combined sewers – full flow and partial flow conditions - design of separate sewers using Manning’s formula.

### **Unit -II: Sewer Materials, Construction and Appurtenances**

Materials for pipe sewers - construction - laying ,jointing, dewatering and testing - sewer appurtenances - traps - plumbing system of drainage – one pipe system and two pipe system of plumbing - sanitary fittings.

### **Unit-III –Sewage Treatment**

Primary treatment - objectives - screening - grit chamber and primary sedimentation tanks design. **Secondary Treatment** Principles, functions and design - activated sludge unit and trickling filter - septic tank - sludge digestion tank - oxidation pond- aerobic reactor- anaerobic reactor.

### **Unit IV- Tertiary Treatment**

Disinfection Systems: Chemicals- Chlorination and other Disinfection methods, UV, Ozonation, Aeration and Gas transfer; Precipitation;

Softening; Adsorption and Ion exchange; Reverse Osmosis Technologies Membrane processes, Ultra Filtration,

### **Unit V- SEWAGE DISPOSAL, SLUDGE MANAGEMENT AND SOLID WASTE MANAGEMENT**

Sewage Disposal – Dilution - self-purification of running streams - oxygen sag curve land disposal - sewage farming - deep well injection - soil dispersion system. Objectives of sludge treatment - properties and characteristics of sludge - sludge digestion - thickening - dewatering - conditioning - drying beds - biogas recovery. solid waste -generation-collection-conveyance-disposal.

#### **Text Books**

1. Wastewater Engineering Treatment and Reuse, Metcalf and Eddy
2. Duggal .K.N, “Elements of Environmental Engineering”, S. Chand & Company Ltd., New Delhi, 2002.

#### **References**

1. Garg .S.K “Sewage Disposal & Air Pollution,” Khanna Publishers, New Delhi, 2004.
2. “Manual on Sewerage & Sewage Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2009.
3. Paneerselvam .R “Environmental Engineering”, Vol. II, SPGS Publishers Chennai, 2006.

**Course Code:** CE 4078  
**Course Name:** Advanced Waste Water Treatment and Design  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

#### **Unit-1 Advance Wastewater treatment design:**

Need for advanced waste water treatment-technologies used for advanced treatment-goals of advanced treatment-combination of unit operations and processes with treatment flow sheets-Effluent polishing.

#### **Unit -2 Nutrient Removal**

Nitrogen – sources, forms, nitrification and denitrification processes-phosphorous –sources, forms, chemical and biological methods of treatment-air stripping.

#### **Unit-3 Adsorption**

Adsorption processes – Adsorption equilibria – Adsorption isotherm – Adsorption kinetics – Influencing factors – Design of adsorption units.

#### **Unit 4 - Filtration and Membrane Process**

Filtration processes – membrane filtration processes – reverse osmosis – membrane properties – ultra filtration – Electrodialysis – process design and applications.

#### **Unit 5 - Ion Exchange and Chemical Oxidation**

Exchange processes – exchange materials – exchange reactions – column design procedure – Application of ion-exchange in water and waste water treatments. Chemical oxidation – principles and theories of chemical oxidation – properties, generation and applications of oxygen, permanganate, chlorine dioxide, etc.

#### **Text Book:**

1. Weber .W.J, “Physiochemical processes for water quality control”, Wiley Interscience, 2002.
2. Metcalf & Eddy., “Wastewater engineering Treatment and Reuse”, Tata McGraw Hill publications, 2003.

#### **References:**

1. Rich .L.G, “Unit operations of sanitary engineers”, Wiley Topan, 2001.
2. Fair .G.M., “Water and Waste water engineering Vol.I & II .John Wiley and Sons”, Newyork, 2005.



**Course Code:** CE 4079  
**Course Name:** Environmental Impact Assessment  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

**Unit I: Introduction** Impact of development projects – Sustainable development- Need for Environmental Impact Assessment (EIA) – Environmental Impact Statement (EIS) – EIA capability and limitations – Legal provisions on EIA-Stages of EIA, Types of EIA

**Unit II: Methodologies:** Methods of EIA – Check lists – Matrices – Networks – Cost-benefit analysis Analysis of alternatives.

**Unit III: Prediction And Assessment:** Assessment of Impact on land, water, air, social & cultural activities and on flora & fauna- Mathematical models- Public participation

**Unit IV: Environmental Management Plan:** Plan for mitigation of adverse impact on environment – Options for mitigation of impact on water, air, land and on flora & fauna – Addressing the issues related to the Project Affected People. Post project monitoring

**Unit V: Case Studies:** EIA for infrastructure projects – Dams – Highways – Multi-storey Buildings, Metros rail, Water Supply and Drainage Projects – Waste water treatment plants, STP.

**Textbooks:**

Canter, R.L., “Environmental Impact Assessment”, McGraw Hill Inc., New Delhi, 1996.

Shukla, S.K. and Srivastava, P.R., “Concepts in Environmental Impact Analysis”, Common Wealth Publishers, New Delhi, 1992.

**REFERENCES:**

John G. Rau and David C Hooten “Environmental Impact Analysis Handbook”, McGraw Hill Book Company, 1990.

“Environmental Assessment Source book”, Vol. I, II & III. The World Bank, Washington, D.C., 1991.

Judith Petts, “Handbook of Environmental Impact Assessment Vol. I & II”, Blackwell Science, 1999.

**Course Code:** CE 4080  
**Course Name:** Industrial Waste Management  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

### **Unit I - Industrialization:**

Industrial activity and environment-industrialization and sustainable development indicators of sustainability-sustainability strategies-Barriers to sustainability- Pollution prevention in achieving sustainability-Prevention Vs control of industrial pollution-Environment policies and Regulations to encourage pollution prevention- Types of industries and industrial pollution - Characteristics of industrial wastes - Population equivalent

### **Unit II - Waste Water Treatment**

Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Dairy, Sugar, distilleries, Refineries, thermal power plants, Chemical Industry, Electroplating Industry - Wastewater reclamation concepts.

### **Unit III - Regulatory Boards**

Environment friendly chemical processes-Properties of environmental contaminants - Regulations for clean environment and implications for industries- International environmental standards-Environmental technology assessment.

### **Unit IV - Source Reduction Techniques**

Waste management Approach - Waste Audit - Volume and strength reduction - Material and process modifications - Recycle, reuse and byproduct recovery - Applications-residuals management-Economic recovery and recycling of wastes.

### **Unit V - Hazardous Waste Management**

Hazardous wastes - Physico chemical treatment - solidification - incineration - Secured land fills-Industrial applications of pollution prevention, Life cycle assessment, and technology assessments.

### **Books**

1. James G. Mann and Y.A.Liu, "Industrial Water Reuse and Waste Water Minimization", McGraw Hill, 2009.
2. Eckenfelder .W.W, "Industrial Water Pollution Control", McGraw-Hill, 2009.

#### Reference

1. Freeman H.M., "Industrial Pollution Prevention Hand Book", McGraw Hill, 2005.
2. Arceivala ,S.J., "Wastewater Treatment for Pollution Control", Tata McGraw- Hill, 2008.
3. Frank Woodard., "Industrial waste treatment Handbook", Butterworth Heinemann, New Delhi, 2010.
4. World Bank Group "Pollution Prevention and Abatement Handbook - Towards Cleaner Production", World Bank and UNEP, Washington D.C.2008.

5. Paul L. Bishop "Pollution Prevention: - Fundamentals and Practice", McGraw-Hill International, 2010.

**Course Code:** CE 4081  
**Course Name:** Design of Environmental Engineering Structures  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

### **Unit-1- Design of Pipes**

Structural design of - Concrete - Prestressed Concrete - Steel - Castiron piping mains- sewerage tanks design – anchorage for pipes – massive outfalls – structural design and laying – hydrodynamic considerations-Advances in the manufacture of pipes.

### **Unit –II Analysis and Design of Water Tanks**

Design of concrete roofing systems - Cylindrical - Spherical - Conical shapes using membrane theory and design of various types of folded plates for roofing with concrete- IS Codes for the design of water retaining structures- Design of circular- rectangular- spherical and Intze type of tanks using concrete- Design of prestressed concrete cylindrical tanks – Economic analysis – introduction to computer aided design and packages.

### **Unit –III Design of Special Purpose Structures**

Underground reservoirs and swimming pools- Intake towers- Structural design including foundation of water retaining structures such as settling tanks clarifloculators- aeration tanks etc – effect of earth pressure and uplift considerations – selection of materials of construction.

### **Unit –IV Repair and Rehabilitation of Structures**

Diagonising the cause and damage- identification of different types of structural and nonstructural cracks – repair and rehabilitation methods for Masonry- Concrete and Steel Structures.

### **Unit –V Environmental Engineering Steel Structures**

Exposure on Steel- Lattice Structures used in water and sewerage works.

### **Text Books**

1. Dayaratnam, P., “Reinforced Concrete”, Khanna Publishers, 2005.
2. Krishna Raju, “Prestressed Concrete”, 2nd Edn, Tata McGraw-ill Publishing Co. 2008.

### **References**

1. Sinha .N.C and Roy .S.K, “Reinforced Concrete”, S.Chand and Co. 2005.
2. Hulse .R and Mosley .W.H, “Reinforced Concrete Design by Computer”, Macmillan Education Ltd., 2006.
3. Ramaswamy .G.S, “Design and Construction of Concrete Shell Roofs”, CBS Publishers, 2006.
4. Green .J.K and Perkins .P.H, “Concrete liquid retaining structures”, Applied Science Publishers, 2001.

**Course Code:** CE 4082  
**Course Name:** RS and GIS for Environmental Engineering  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

**Unit-1- Remote Sensing Application in Environmental Engg.**

Introduction – Environmental Satellites: GOES, NOAA, AVHRR, CZCR –Monitoring land, water, atmosphere and ocean using Remote Sensing data – Case studies.

**Unit –II - Soil Degradation Study Using GIS and Remote Sensing**

Taxonomical classification of soils – soil survey Interpretation and mapping – Impact of agricultural and Industrial activity on soil properties – Soil salinity / alkalinity, erosion studies – Application of GIS in assessing soil salinity, erosion productivity etc.,

**Unit –III - GIS in water quality management**

Classification of water quality-Conceptualization of Hydrogeology- Aspects of Water Budget-Database creation and Water quality modeling using GIS. Database creation and maintaining water supply network – Case studies.

**Unit –IV - GIS Application in Pollution Monitoring and Modeling**

Aquifer – Vulnerability Intrinsic & Specific Vulnerability, DRASTIC, SINTACS MODELS, MODFLOW, MT3D, contaminant transport model

**Unit –V- GIS Applications in Air Quality Monitoring and Modeling**

Atmosphere: chemicals, Particulate matters present in the atmosphere, allowable limits –Remote Sensing technique to monitor atmosphere constituents, air pollution due to industrial activity – monitoring & modeling using GIS.

**Text Book**

1. Sabins .F, “Remote Sensing Principles and Interpretation”, W. H. Freeman and Company, 2007.

**Reference**

1. “World in transition: The threat to Soils” Annual Report of the Germon Advisory Council on Global change, Economical Verlag, 2004.
2. “Ground Water vulnerability assessment: Predicting Relative Contamination Potential Under Conditions of Uncertainty”, National Academic Press, 2003.
3. Savigny. D. and Wijeyaratne .P., “GIS for Health and Environment”, Stylus Publication, 2005.
4. Allaric Sample .V., “Remote Sensing and GIS for Eco System Management”. Island Press, 2006.

**Course Code:** CE 4083  
**Course Name:** Sustainable and Recyclable Materials  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

***Module 1:***

Overview of different construction materials and their carbon foot print, Embodied and process energies of materials

***Module 2:***

Bamboo: Bamboo and its characteristics, bamboo resources and its potential in India, engineered bamboo for urban constructions,

Building with raw earth, stabilized earth and rammed earth

***Module 3:***

Alkaline activated systems and geopolymer concrete systems, Chemistry, material characteristics, strength and durability aspects and long term performance

***Module 4:***

Binary and ternary blended cement and concrete systems chemistry and material composition, strength short and long term, durability aspects

***Module 5:***

Life cycle assessment of sustainable materials, green certifications and other guidelines

**Reference Book/Materials:**

1. Davidovits, Joseph. Geopolymer chemistry and applications. Geopolymer Institute, 2008.
2. Publications on Limestone calcined clay concrete, Bamboo structures.

**Course Code:** CE 4084  
**Course Name:** Advanced Steel Structures  
**Credits:** 3 (3-0-0)  
**Course position:** Semester 6, 7 or 8

## **Course Content**

### **Module I: Review of Structural Steel and Design of Moment-Resisting Connections**

Mechanical properties of steel, cold working and strain hardening; Philosophy, concept and methods of design of steel structures; Types frames and structural forms; Brief-review of member and simple connection designs.

Moment-resisting connections: - Connections Subjected to Eccentric Shear – Bolted Framed Connections- Bolted Seat Connections – Bolted Bracket Connections. Bolted Moment Connections – Welded Framed Connections – Welded Bracket Connections.

### **Module II: Design of Beam-Column**

Beam-column design: General Behavior of Beam-columns; Equivalent Moment Factor; Nominal Strength-Instability in the Plane of Bending; Beam-columns Subjected to Tension and Bending; Design of Eccentrically Loaded Base Plates

### **Module III: Design of Plate and Gantry Girder**

Design of Plate Girder: Preliminary Design Procedure; Web Panel Subjected to Shear; Behavior of Transverse Web Stiffeners; Design using IS 800: 2007; Welding of Girder Components; Proportioning of the Section.

Design of Gantry Girder: Loading Considerations; Maximum Load Effects; Fatigue Effects; Selection of Gantry Girder; Design.

### **Module IV: Design of Industrial Buildings and Trusses**

Analysis and Design of Industrial Buildings: Dead loads, live loads and wind loads on roofs. Design wind speed and pressure, wind pressure on roofs; wind effect on cladding and louvers; Design of angular roof truss, tubular truss, truss for a railway platform. Design of purlins for roofs, design of built up purlins, design of knee braced trusses and stanchions. Design of bracings.

Types of truss bridges, component parts of a truss bridge, economic proportions of trusses, self-weight of truss girders, design of bridge compression members, tension members; wind load on truss girder bridges; wind effect on top lateral bracing; bottom lateral bracing; portal Bracing; sway bracing.

### **Module V: Design of Silos**

Design of Steel Bunkers and Silos: Introduction – Janseen’s Theory – Airy’s Theory – Design of Parameters – Design Criteria – Analysis of Bins – Hopper Bottom –Design of Bins.

### **Programming using MATLAB, Python and Macros in MS Excel:**

Design of Simple and Moment resisting connections; Design of plate girders; Design of truss bridges;

#### **Text Books**

- N. Subramanian; *Design of Steel Structures*, Oxford University Press 2016. ISBN-13:978-0-19-946091-5.
- Design Steel Structures Volume – II, Dr. Ramachandra & Vivendra Gehlot, Scientific Publishers Journals Department.
- Graham W. Owen and Brian D. Cheal; *Structural Steelwork Connections*, Butterworth-Heinemann (August 1, 1989), ISBN-10: 0408012145

#### **Reference Books**

- S. Duggal; *Limit State Design of Steel Structures*, Mc Graw Hill Education, 5<sup>th</sup> Edition. ISBN-10 9351343499.
- Abi O. Aghayere; *Structural Steel Design: A Practice Oriented Approach*, Pearson eISBN: 9781282660656 (ebook available).