

**Indian Institute of Technology Patna**  
**Department of Civil and Environmental Engineering**  
**Bachelor of Technology in Civil Engineering**

In India, population explodes before even a plan is conceived. Population explosion coupled with urbanization, industrialization and economic growth have resulted in overstressing and deterioration of nation's public infrastructures including building, roads, bridges, water and power distribution systems, storm and sanitary sewers, waste management, etc. The problem is exacerbating in urban areas due to mushrooming of unplanned infrastructure development. Deterioration of public infrastructure ultimately impacts consumers as well as business due to increase in costs. Moreover, there should be proper interlink between technological demand and societal needs while attempting challenges in infrastructure sector. Keeping in mind the infrastructure requirements for improved quality of life in a growing society as well as for industry and economic development, the need of the hour is to amalgamate traditional Civil Engineering with Infrastructure Engineering and Management with interdisciplinary approach. The multi-dimensional approach is perceived to close the socio-techno-economical loop by assessing the infrastructure needs accurately, proper decision-making in allocating resources, relating technological supply to socio-economic needs and most importantly, keeping a balance between economic development and environmental impact.

In order to satisfy the current societal needs and growing industry demands, the B.Tech in Civil Engineering program under the aegis of Department of Civil and Environmental Engineering at Indian Institute of Technology Patna intends to be the forefront of imparting engineering education by amalgamating traditional Civil Engineering with modern Infrastructure Engineering. The program aims to emphasize application oriented and project-based learning. A strategic approach and motives behind the development of such a curriculum are outlined as follows:

**Vision:** In order to steer the growth of modern India in a planned manner, the curriculum of Civil Engineering intends to be recognized for inspiring and developing future leaders who solve society's infrastructure challenges.

**Mission:** To develop a brigade of young graduates capable of planning, developing, maintaining and managing public infrastructures for transformation of society through the provision of world class teaching, research and training engagements in interdisciplinary learning environment.

**Objectives:** To develop an undergraduate curriculum in Civil Engineering that will emphasize on following aspects:

- (i) Imparting education with an integrated view of infrastructure based on modern societal needs with traditional wisdom,
- (ii) Interaction between various disciplines to cope up with growing real world challenges pertaining to infrastructure, and
- (iii) Inculcating young minds to learn various tools/techniques and develop capabilities in problem solving, engineering analysis, sustainability, teamwork, leadership and communications.

**Goals:** The goals are to:

- (i) Adopt an integrated view on infrastructure,
- (ii) Understand the need to plan, develop, maintain and manage public infrastructure at a high level,

- (iii) Recognize the necessity of life cycle considerations in achieving the best operation of public infrastructures,
- (iv) Enhance the performance of civil infrastructure systems through product innovation and process integration,
- (v) Plan and execute the development of infrastructure projects,
- (vi) Evaluate critically the infrastructure policies and projects, and
- (vii) Lead and communicate effectively to team members and clients.

The features of the curriculum are as follows:

- (i) Year one introduces key graduate capabilities in extending science-based basic concepts and knowledge to engineering applications for problem solving,
- (ii) Year two concentrates on the basic theoretical ideas around Civil and Infrastructure Engineering,
- (iii) Year three covers the hardcore areas in Civil and Infrastructure Engineering including structure, geotechnical, transport, water resources and environment.
- (iv) Year four revolves around the application oriented and project-based learning in hardcore areas covered in Year three. Additionally, the development of expertise in various specializations is also possible through the introduction of widely-diverse departmental elective courses in Year four.

## CURRICULUM

### 1st Year:

#### First Semester:

Subject ID	Subject	L-T-P	Credits
CH101	Chemistry – I	3-1-0	8
CH110	Chemistry Laboratory	0-0-3	3
EE101	Electrical Sciences	3-1-0	8
MA101	Mathematics – I	3-1-0	8
ME111	Engineering Drawing	2-0-3	7
PH101	Physics – I	2-1-0	6
ME110	Workshop	0-0-3	3
HS101	English: Learning Through Literature	3-0-0	6
	<b>Sub-Total</b>	16-4-9	49

#### Second Semester:

Subject ID	Subject	L-T-P	Credits
CH102	Chemistry – II	3-0-0	6
CS101	Introduction to Computing	3-0-0	6
CS110	Computing Laboratory	0-0-3	3
EE102	Basic Electronics Laboratory	0-0-4	4
MA102	Mathematics – II	3-1-0	8
ME101	Engineering Mechanics	3-1-0	8
PH110	Physics Laboratory	0-0-3	3
PH102	Physics – II	2-1-0	6
	<b>Sub-Total</b>	14-3-10	44

### 2nd Year:

#### Third Semester:

Subject ID	Subject	L-T-P	Credits
MA201	Mathematics – III	3-1-0	8
CS201	Object Oriented Programming and Data Structures	3-0-3	9
HS2××	HSS Elective – I	3-0-0	6
CE201	Introduction to Materials and Solid Mechanics	3-0-0	6
CE203	Geomatics Engineering	3-0-0	6
CE205	Fluid Mechanics and Hydraulics	3-0-0	6
CE207	Fluid Mechanics and Hydraulics Laboratory	0-0-3	3
	<b>Sub-Total</b>	18-1-6	44

HSS Elective – I:	
Subject ID	Subject
HS201	Introductory Microeconomics
HS221	Fundamentals of Linguistics Science
HS231	Introductory Sociology

**Fourth Semester:**

Subject ID	Subject	L-T-P	Credits
HS2××	HSS Elective – II	3-0-0	6
XX2××	Science Elective	3-0-0	6
CE202	Structural Analysis	3-1-0	8
CE204	Irrigation and Flood Control Engineering	3-0-0	6
CE206	Introduction to Soil Mechanics and Foundation Engineering	3-0-0	6
CE208	Numerical Methods for Civil and Infrastructure Engineering	3-0-0	6
CE210	Soil Mechanics Laboratory	0-0-3	3
CE212	Geomatics Engineering Laboratory	0-0-3	3
	<b>Sub-Total</b>	<b>18-1-6</b>	<b>44</b>

HSS Elective – II:	
Subject ID	Subject
HS202	Introductory Macroeconomics
HS211	Literature: Voices and Culture
HS223	Cognition: Language and Computation

Science Elective:	
Subject ID	Subject
CH201	Green Chemistry and Technology
MA214	Introduction to Computational Topology
MA251	Optimization Techniques

**3rd Year:****Fifth Semester:**

Subject ID	Subject	L-T-P	Credits
CE301	Design of Reinforced Concrete Structures	3-1-0	8
CE303	Water Supply and Wastewater Engineering	3-0-0	6
CE305	Transportation Engineering	3-0-0	6
CE307	Construction Planning and Management	3-0-0	6
CE309	Building Design, Estimation and Construction	2-0-3	7
CE311	Structural Laboratory	0-0-3	3
CE313	Transportation Engineering Laboratory	0-0-3	3
	<b>Sub-Total</b>	<b>14-1-9</b>	<b>39</b>

**Sixth Semester:**

Subject ID	Subject	L-T-P	Credits
HS3××	HSS Elective – III	3-0-0	6
CE302	Design of Steel Structures	3-1-0	8
CE304	Infrastructure Planning, Management and Evaluation	3-0-0	6
CE306	Town and Regional Planning	3-0-0	6
CE308	Machineries in Infrastructure Engineering	3-0-0	6
CE3××	Major Departmental Elective	3-0-0	6
CE310	Environmental Quality and Pollution Measurement Laboratory	0-0-3	3
CE312	Seminar	0-0-3	3
	<b>Sub-Total</b>	<b>18-1-6</b>	<b>44</b>

<b>HSS Elective – III:</b>	
<b>Subject ID</b>	<b>Subject</b>
HS311	Diasporic Literature
HS331	Sociology of Development

<b>Major Departmental Elective:</b>	
<b>Subject ID</b>	<b>Subject</b>
CE314	Earthquake Resistant Design of Structures
CE316	Advanced Soil Mechanics and Foundation Engineering
CE318	Solid Waste Management
CE320	Traffic Engineering
CE322	Hydrology

#### 4<sup>th</sup> Year:

##### Seventh Semester:

<b>Subject ID</b>	<b>Subject</b>	<b>L-T-P</b>	<b>Credits</b>
CE400	Summer Internship	0-0-2	2
CE401	Infrastructure Laws and Professional Ethics	3-0-0	6
CE403	Infrastructure Project Economics, Valuation and Contracts	3-0-0	6
CE4××	Departmental Elective – I	3-0-0	6
CE4××	Departmental Elective – II	3-0-0	6
XX4××	Open Elective – I	3-0-0	6
CE498	Project – I	0-0-8	8
	<b>Sub-Total</b>	15-0-10	40

<b>Departmental Elective – I:</b>	
<b>Subject ID</b>	<b>Subject</b>
CE405	Theory of Elasticity and Plasticity
CE407	Theory of Elastic Stability
CE409	Finite Element Method in Civil Engineering
CE411	Integrated Region and Smart City
CE413	High-rise Structures
CE415	Intelligent Building Automation System
CE417	Soil Exploration and Ground Improvement Techniques
CE419	Groundwater Hydrology
CE421	Railway Engineering
CE423	Design of Water Treatment Infrastructures
CE425	Environmental Hydraulics

<b>Departmental Elective – II:</b>	
<b>Subject ID</b>	<b>Subject</b>
CE427	Prestressed Concrete
CE429	Composite Structure
CE431	Design of Lifeline Structures
CE433	Soil Dynamics and Machine Foundation Design
CE435	Design of Hydraulic Structures
CE437	Statistical Methods in Hydrology
CE439	Pavement Design and Management
CE441	Sanitation Techniques
CE443	Air Pollution Control Techniques
CE445	Transmission Tower Design, Erection and Maintenance
CE/EE447	Design and Layout of Electrical Distribution Systems

<b>Open Elective – I:</b>	
<b>Subject ID</b>	<b>Subject</b>
CS401	Foundations of Computer Science
MA410	Graphs, Groups and Network
ME481	Introduction to Biomechanics
PH401	Introduction to Nanomaterials
PH402	Solid State Devices
ME449	Refrigeration and Air Conditioning
ME461	Robotics and Robot Applications
CS461	Artificial Intelligence

***Eighth Semester:***

<b>Subject ID</b>	<b>Subject</b>	<b>L-T-P</b>	<b>Credits</b>
CE499	Project – II	0-0-16	16
CE4xx	Departmental Elective – III	3-0-0	6
CE4xx	Departmental Elective – IV	3-0-0	6
XX4xx	Open Elective – II	3-0-0	6
HS4xx	HSS Elective – IV	3-0-0	6
	<b><i>Sub-Total</i></b>	12-0-16	40

<b>Departmental Elective – III:</b>	
<b>Subject ID</b>	<b>Subject</b>
CE402	Risk and Reliability Analyses of Civil Infrastructure
CE404	Probabilistic Methods in Civil Engineering
CE406	Disaster Management
CE408	Theory of Plates and Shells
CE410	Structural Health Monitoring and Retrofitting
CE412	Green Building System
CE414	Inspection and Repair of Foundations
CE416	River Engineering
CE418	Airport Systems Planning and Design
CE420	Design of Sewerage and Wastewater Treatment Infrastructures
CE422	Hazardous Waste Management
CE424	Heavy Construction Methods and Machines

<b>Departmental Elective – IV:</b>	
<b>Subject ID</b>	<b>Subject</b>
CE426	Structural Optimization
CE428	Soil-Structure Interaction
CE430	Reinforced Earth
CE432	Introduction to Remote Sensing and GIS
CE434	Offshore Infrastructures
CE436	Urban Transportation Systems Planning
CE438	Environmental Management in Industries
CE440	Environmental Statistics and Experimental Design
CE444	<b>Occupational Health, Safety and Quality Management</b>
CE446	Computer Aided Design of Civil Infrastructures
CE448	Financial Models for Infrastructure Projects
CE450	Special Topics in Infrastructure Engineering
EE751	<i>Modeling and Simulation of Modern Power Systems</i>

<b>Open Elective – II:</b>	
<b>Subject ID</b>	<b>Subject</b>
MA412	Matrix Computation
PH403	Photovoltaics & Fuel Cell Technology
CE442	Industrial Waste Treatment and Management
ME446	<i>Composite Materials and Engineering</i>
EE483	<i>Distributed Energy Resources</i>
EE491	<i>Visual Surveillance Systems</i>

<b>HSS Elective – IV:</b>	
<b>Subject ID</b>	<b>Subject</b>
HS421	Fundamentals of Cognitive Science
HS441	Industrial and Organizational Psychology

**Total Credits: 49+44+44+44+39+44+40+40 = 344**

**Semester-wise Break-up of Contact Hours (L-T-P):**

Course Category	Semester								Total
	I	II	III	IV	V	VI	VII	VIII	
Physics	2-1-0	2-1-3	-	3-0-0	-	-	3-0-0	3-0-0	28-6-6 (40)
Chemistry	3-1-3	3-0-0	-		-	-			
Mathematics	3-1-0	3-1-0	3-1-0		-	-			
HSS	3-0-0	-	3-0-0	3-0-0	-	3-0-0	-	3-0-0	15-0-0 (15)
Basic Engineering	5-1-6	6-1-7	6-0-3	-	-	-	0-0-10	0-0-16	17-2-42 (61)
Departmental Core	-	-	6-0-3	12-1-6	14-1-9	15-1-6	6-0-0	-	53-3-24 (80)
Departmental Elective	-	-	-	-	-	-	6-0-0	6-0-0	12-0-0 (12)
<b>Total</b>	<b>16-4-9 (29)</b>	<b>14-3-10 (27)</b>	<b>18-1-6 (25)</b>	<b>18-1-6 (25)</b>	<b>14-1-9 (24)</b>	<b>18-1-6 (25)</b>	<b>15-0-10 (25)</b>	<b>12-0-16 (28)</b>	<b>125-11-72 (208)</b>



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**SYLLABUS**

**1st Year:**

***First Semester:***

**CH 101 Chemistry – I**

**3-1-0-8**

Thermodynamics: The fundamental definition and concept, the zeroth and first law. Work, heat, energy and enthalpies. The relation between  $C_v$  and  $C_p$ . Second law: entropy, free energy (the Helmholtz and Gibbs) and chemical potential. Change of Phase: Clapeyron-Clausius equation. Third law. Chemical equilibrium, Chemical kinetics: The rate of reaction, elementary reaction and chain reaction. Electrochemistry: Conductance of solutions, equivalent and molar conductivities and its variation with concentration. Kohlrausch's law-ionic mobilities, Transference number of ions. Activities in electrolytic solutions, application of Debye-Huckel theory. The Walden's rule. Debye-Huckel-Onsager treatment. Electrochemical cells, Nernst equation. Application of EMF measurements. Liquid junction potential, commercial cells – the primary and secondary cells. Fuel cells. Polarisation and overvoltage.

The periodic table of elements, shapes of inorganic compounds, chemistry of materials. Coordination compounds: ligand, nomenclature, isomerism, stereochemistry, valence bond, crystal field and molecular orbital theories. Bioinorganic chemistry and organometallic chemistry.

Stereo and regio-chemistry of organic compounds, conformers. Bioorganic chemistry: amino acids, peptides, proteins, enzymes, carbohydrates, nucleic acids and lipids. Modern techniques in structural elucidation of compounds (UV – Vis, IR, NMR). Solid phase synthesis and combinatorial chemistry. Green chemical processes.

**Texts:**

- P. W. Atkins, Physical Chemistry, ELBS, 5th Ed, 1994.
- J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Volume 1 and 2, Kluwer Academic, 2000.
- K. L. Kapoor, A Textbook of Physical Chemistry, Macmillan India, 2nd Ed, 1986.
- F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, Wiley Eastern Ltd, New Delhi, 3rd Ed, 1972 (reprint in 1998).
- D. J. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, ELBS, 2nd Ed, 1994.
- S. H. Pine, Organic Chemistry, McGraw Hill, 5th Ed, 1987

**References:**

- I. A. Levine, Physical Chemistry, McGraw Hill, 4th Ed, 1995.
- J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principle, structure and reactivity, Harper Collins, 4th Ed, 1993.
- L. G. Wade Jr., Organic Chemistry, Prentice Hall, 1987.

**CH 110 Chemistry Lab**

**0-0-3-3**

Estimation of metal ion: Determination of total hardness of water by EDTA titration. Experiments based on chromatography: Identification of a mixture containing two organic compounds by TLC. Experiments based on pH metry.: Determination of dissociation constant of weak acids by pH meter. Experiments based on conductivity measurement: Determination of amount of HCl by conductometric titration with NaOH. Synthesis and characterization of inorganic complexes: e.g.  $Mn(acac)_3$ ,  $Fe(acac)_3$ , cis-bis(glycinato)copper(II) monohydrate and their characterization by m. p. IR etc. Synthesis and characterization of organic compounds: e.g. Dibenzylideneacetone. Kinetics: Acid catalyzed hydrolysis of methylacetate. Verification of Beer-Lamberts law and determination of amount of iron present in a supplied solution. Experiments based on electrogravimetry and electroplating. Experiments based on magnetometry.

**EE 101 Electrical Sciences**

**3-1-0-8**

Circuit Analysis Techniques, Circuit elements, Simple RL and RC Circuits, Kirchoff's law, Nodal Analysis, Mesh Analysis, Linearity and Superposition, Source Transformations, Thevenin's and Norton's Theorems, Time Domain Response of RC, RL and RLC circuits, Sinusoidal Forcing Function, Phasor Relationship for R, L and C, Impedance and Admittance.

Semiconductor Diode, Zener Diode, Rectifier Circuits, Clipper, Clamper, Bipolar Junction Transistors, Transistor Biasing, Transistor Small Signal Analysis, Transistor Amplifier, Operational Amplifiers, Op-amp Equivalent Circuit, Practical Op-amp Circuits, DC Offset, Constant Gain Multiplier, Voltage Summing, Voltage Buffer, Controlled Sources, Instrumentation Circuits, Active Filters and Oscillators.

Number Systems, Logic Gates, Boolean Theorem, Algebraic Simplification, K-map, Combinatorial Circuits, Encoder, Decoder, Combinatorial Circuit Design, Introduction to Sequential Circuits. Magnetic Circuits, Mutually Coupled Circuits, Transformers, Equivalent Circuit and Performance, Analysis of Three-Phase Circuits, Electromechanical Energy Conversion, Introduction to Rotating Machines.

#### **Texts/References:**

- C. K. Alexander, M. N. O. Sadiku, Fundamentals of Electric Circuits, 3rd Edition, McGraw-Hill, 2008.
- W. H. Hayt and J. E. Kemmerly, Engineering Circuit Analysis, McGraw-Hill, 1993.
- Donald A Neamen, Electronic Circuits; analysis and Design, 3rd Edition, Tata McGraw-Hill Publishing Company Limited.
- Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, 5th Edition, Oxford University Press, 2004.
- R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 6th Edition, PHI, 2001.
- M. M. Mano, M. D. Ciletti, Digital Design, 4th Edition, Pearson Education, 2008.
- Floyd, Jain, Digital Fundamentals, 8th Edition, Pearson.
- A. E. Fitzgerald, C. Kingsley Jr., S. D. Umans, Electric Machinery, 6th Edition, Tata McGraw-Hill, 2003.
- D. P. Kothari, I. J. Nagrath, Electric Machines, 3rd Edition, McGraw-Hill, 2004.

#### **MA 101 Mathematics – I**

**3-1-0-8**

Properties of real numbers. Sequences of real numbers, monotone sequences, Cauchy sequences, divergent sequences. Series of real numbers, Cauchy's criterion, tests for convergence. Limits of functions, continuous functions, uniform continuity, monotone and inverse functions. Differentiable functions, Rolle's theorem, mean value theorems and Taylor's theorem, power series. Riemann integration, fundamental theorem of integral calculus, improper integrals. Application to length, area, volume, surface area of revolution. Vector functions of one variable and their derivatives. Functions of several variables, partial derivatives, chain rule, gradient and directional derivative.

Tangent planes and normals. Maxima, minima, saddle points, Lagrange multipliers, exact differentials. Repeated and multiple integrals with application to volume, surface area, moments of inertia. Change of variables. Vector fields, line and surface integrals. Green's, Gauss' and Stokes' theorems and their applications.

#### **Texts:**

- G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 6th Ed/ 9th Ed, Narosa/ Addison Wesley/ Pearson, 1985/ 1996.
- T. M. Apostol, Calculus, Volume I, 2nd Ed, Wiley, 1967.
- T. M. Apostol, Calculus, Volume II, 2nd Ed, Wiley, 1969.

#### **References:**

R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 5th Ed, Wiley, 1999.

- J. Stewart, Calculus: Early Transcendentals, 5th Ed, Thomas Learning (Brooks/ Cole), Indian Reprint, 2003.

#### **ME 111 Engineering Drawing**

**2-0-3-7**

**Geometrical construction of simple plane figure:** Bisecting the line, draw perpendicular, parallel line, bisect angle, trisect angle, construct equilateral triangle, square, polygon, inscribed circle.

**Free hand sketching:** prerequisites for freehand sketching, sketching of regular and irregular figures.

**Drawing scales:** Engineering scale, graphical scale, plane scale, diagonal scale, comparative scale, scale of chord.

**Orthographic projection:** Principle of projection, method of projection, orthographic projection, plane of projection, first angle of projection, third angle of projection, reference line.

**Projection of points, lines and plane:** A point is situated in the first quadrant, point is situated in the second quadrant, point is situated in the third quadrant, point is situated in the fourth quadrant, projection of line parallel to both the plane, line contained by one or both the plane, line perpendicular to one of the plane, line inclined to one plane and parallel to other, line inclined to both the plane, true length of line.

**Missing views:** Drawing of missing front view of a solid, missing top view of solids, missing side view of solids, Orthographic projection of simple solid: Introduction, types of solid, projection of solid when axis perpendicular to HP, axis perpendicular to VP, axis parallel to both HP and VP, axis inclined to both HP and VP.

**Orthographic projection of simple solid:** Introduction, types of solid, projection of solid when axis perpendicular to HP, axis perpendicular to VP, axis parallel to both HP and VP, axis inclined to both HP and VP.

#### **Texts and References:**

- B. Agrawal and CM Agrawal, Engineering Drawing, Tata McGraw-Hill Publishing Company Limited, 2008.
- D. A. Jolhe, Engineering Drawing, Tata McGraw-Hill Publishing Company Limited, 2006.
- K. Venugopal, Engineering Drawing and Graphics, 2<sup>nd</sup> ed., New Age International, 1994.

**PH 101 Physics – I****2-1-0-6**

Classical Mechanics: Position, velocity and acceleration vectors in plane polar coordinate. Newton's laws of motion. Fundamental forces. Contact forces. System of Particles. Conservation of momentum. Work-energy theorem. Line integral of a vector field. Conservative forces. Gradient of a scalar field. Potential energy and equilibrium. Conservation of energy. Angular momentum. Rotation about fixed axis. Torque. Motion involving translation and rotation. Vector nature of angular velocity and angular momentum. The Gyroscope. Pseudo forces. Rotating frame. Centrifugal and Coriolis forces. Foucault pendulum. Special Theory of Relativity: Result of Michelson-Morley Experiment. Postulates of STR. Galilean transformation. Lorentz transformation. Simultaneity. Length contraction. Time dilation. Relativistic addition of velocities. Quantum Mechanics: Failure of classical concepts. De Broglie's hypothesis. Davison and Germer's experiment. Uncertainty Principle, Wave packets. Phase and Group velocities. Schrodinger equation. Probabilities and Normalization. Expectation values. Eigenvalues and eigenfunctions. Applicationa in one dimension: Particle in a box, Finite Potential well, Steps and Barriers, Harmonic oscillator.

**Text:**

- D. Kleppner and R. J. Kolenkow, An Introduction to Mechanics, Tata McGraw-Hill, New Delhi, 2000.
- K. Krane, Modern Physics, John Wiley, Singapore, 1998.

**References:**

- R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture in Physics, Vol I, Narosa Publishing House, New Delhi, 1998.
- J. M. Knudsen and P. G. Hjorth, Elements of Newtonian Mechanics, Springer, 1995.
- R. Resnick, Introduction to Special Relativity, John Wiley, Singapore, 2000.
- A. Beiser, Concepts of Modern Physics, Tata McGraw-Hill, New Delhi, 1995.

**ME 110 Workshop****0-0-3-3**

**Carpentry:** Introduction to wood working, Marking and Measuring Tools-rule, try square, marking gauge, mortise gauge etc., Cutting Tools-rip saw, tenon saw, firmer chisel, mortise chisel, iron jack plane, wooden jack plane etc., Drilling Tools-braces, drill bits etc., Striking Tools-hammers, mallet etc., Holding Tools-bench vice, G-cramp etc., Miscellaneous Tools- rasps, files, screw driver, pincer etc.; Operations-marking, sawing, planning, chiseling, boring, grooving etc., Joints- Corner joints, Tenon and Mortise joint, Briddle cross-joint.

**Fitting:** Introduction to fitting, Tools-bench vice, hammers, chisels, files-flat file, square file, half round file, round file, knife edge file, scrapers, hacksaws, try squares, drill machine, drill bits, taps, dies etc, Operations-chipping, filing, scrapping, sawing, marking, drilling, tapping, dieing etc.;

**Sheet Metal Working:** Introduction to sheet metal work; GI sheets, aluminium, tin plate, copper, brass etc, Toolssteel rule, vernier calipers, micrometer, sheet metal gauge etc., scriber, divider, punches, chisels, hammers, snips, pliers, stakes, rivets etc., Operations-shearing, bending, drawing, squeezing etc.

**Pattern making and Foundry:** Introduction to pattern making, moulding and foundry practice. Pattern material-wood, cast iron, brass, aluminium, waxes etc., different types of patterns, core-boxes, core prints, hand tools-shovel, riddle, rammer, trowel, slick, lifter, sprue pin, bellow, mallet, vent rod, pouring weights etc., moulding sands-green sand, dry sand, loam sand, facing sand etc., grain shape and size, properties of moulding sand, sand preparation and testing etc., casting- permanent mould casting, centrifugal casting etc.

**Texts and References:**

- Hajra Choudhury, Hazra Choudhary and Nirjhar Roy, 2007, Elements of Workshop Technology, vol. I, Media promoters and Publishers Pvt. Ltd.
- W A J Chapman, Workshop Technology, 1998, Part -1, 1st South Asian Edition, Viva Book Pvt Ltd.
- P. N. Rao, 2009, Manufacturing Technology, Vol.1, 3rd Ed., Tata McGraw Hill Publishing Company.
- Kaushish J.P., Manufacturing Processes, 2008, Prentice Hall India.

**HS 101 English: Learning Through Literature****3-0-0-6****Essays**

- Freedom by George Bernard Shaw
- Student Mobs by J.B. Priestley

**Short Stories**

- The Three Dancing Goats- A Folk Tale (Anonymous)
- The Fortune Teller by Karel Capek
- Grief by Anton Chekov

**One-Act Play**

- Refund by Fritz Karinthy

**Poems**

- Night of the Scorpion by Nissim Ezekiel
- Porphyria's Lover by Robert Browning

**Texts:**

- 'Essays, Short Stories and One-Act Plays' ed. By R.K. Kaushik and S.C. Bhatia, Oxford University Press, 1975

**References:**

- Krishna Mohan and Meera Banerji, Developing Communication Skills, Macmillan India Ltd.
- John Eastwood, Oxford Practice Grammar, Oxford, New Delhi, 2005

*Second Semester:***CH 102 Chemistry – II****3-0-0-6****Module 1: Polymer Chemistry****Unit 1: Polymer Chemistry in Everyday Life**

- Introduction to polymer chemistry.
- Plastics, reinforced plastics & rubbers: production of household goods.
- Polymers in medicine and drugs, surgery and cosmetics.

**Module 2: Introduction to Chemical Biology****Unit 1: Biochemical evolution and cell**

- Molecular evolution of Life: Biochemical evolution, the first cell.
- Cell Structure and types, Different organelles and function, cell division.
- Basic concept of Embryonic stem cell.

**Unit 2: Methods in Chemical Biology**

- Chemical Methods to synthesize artificial Proteins and peptides.
- Chemical Methods to synthesize artificial DNA and RNA.

**Unit 3: Recombinant DNA Technology**

- Recombinant DNA technology-concept of Cloning.
- Concepts of Gene and genome, Gene transfer and Gene therapy
- DNA fingerprinting: application in Forensic Science (crime investigation & parental testing).

**Module 3: Chemistry of Environment****Unit 1: Environment and Ecosystem: Basics**

- Basic idea and definition of environment and ecosystem and important components.
- Environmental protection and Hazards- importance and identification of sources.

**Unit 2: Technology for Air and Water Pollution Control**

- Air Pollutants and their effect on Health.
- Sources of air pollution- artificial and natural, "Clean Air Act"
- Technology for air pollution control: Particulate control, Scrubbers, catalytic converters, VOC abatement.
- Water pollution categories: point and non point source.
- Industrial and domestic waste water management.

**Unit 3: Alternative Energy Sources**

- Biofuels: alcohol, hydrogen production technology, Biofuels from Jatropa.
- Green energy: sources, efficiency and sustainability; Energy from Biomass and solid waste.
- Renewable energy resources: solar, wind, hydro, geothermal, ocean, fuel cells.

**Texts:**

- Polymer Chemistry, Malcolm P. Stevens, Oxford University Press Inc., 3rd Edition, 1998.
- Chemistry of the Environment, Bailey, Clark, Ferris, Krause & Strong, 2nd Edition, Academic Press (Elsevier).
- Environmental Engineering, R. Srinivasan, Prentice Hall of India Pvt. Ltd.
- Biotechnology, B. D. Singh, Kalyani Publishers, 1st Edition, 2005.

**References:**

- Renewable Energy Sources and Emerging Technologies, D. P. Kothari, Rakesh Ranjan and K. C. Saigal, Prentice Hall of India Pvt. Ltd.
- Polymer Science and Technology - 2nd edition, Fried Joel R., PHI Learning.
- Biotechnology: An Introduction, Susan R. Bernum, Wadsworth Pub. Co.

**CS 101 Introduction to Computing****3-0-0-6**

Digital computer fundamentals: flowcharts, the von Neumann architecture, programs, assembly language, high level programming languages, text editors, operating systems. Imperative programming (Using C): data types, variables, operators, expressions, statements, control structures, functions, arrays and pointers, recursion, records (structures),

files, input/output, some standard library functions and some elementary data structures. Program development: programming tools, testing and debugging.

**Texts:**

- A. Kelley and I. Pohl, A Book on C, 4th Ed, Pearson Education, 1998.

**References:**

- B. W. Kernighan and D. Ritchie, The C Programming Language, 2nd Ed, Prentice Hall of India, 1988.

**CS 110 Computing Laboratory**

**0-0-3-3**

Laboratory experiments will be set in consonance with the material covered in CS 101. This will include assignments in a programming language like C.

**References:**

- Kernighan B., Ritchie D., The Programming Language, Prentice Hall India, 1995.

**EE 102 Basic Electronics Laboratory**

**0-0-4-4**

Experiments using diodes and bipolar junction transistor (BJT): design and analysis of half -wave and full-wave rectifiers, clipping circuits and Zener regulators, BJT characteristics and BJT amplifiers; experiments using operational amplifiers (op-amps): summing amplifier, comparator, precision rectifier, astable and monostable multivibrators and oscillators; experiments using logic gates: combinational circuits such as staircase switch, majority detector, equality detector, multiplexer and demultiplexer; experiments using flip-flops: sequential circuits such as non-overlapping pulse generator, ripple counter, synchronous counter, pulse counter and numerical display.

**References :**

- A. P. Malvino, Electronic Principles. New Delhi: Tata McGraw-Hill, 1993.
- R. A. Gayakwad, Op-Amps and Linear Integrated Circuits. New Delhi: Prentice Hall of India, 2002.
- R.J. Tocci: Digital Systems; PHI, 6e, 2001.

**MA 102 Mathematics – II**

**3-1-0-8**

**Linear Algebra:** Vector spaces (over the field of real and complex numbers). Systems of linear equations and their solutions. Matrices, determinants, rank and inverse. Linear transformations. Range space and rank, null space and nullity. Eigenvalues and eigenvectors. Similarity transformations. Diagonalization of Hermitian matrices. Bilinear and quadratic forms.

**Ordinary Differential Equations:** First order ordinary differential equations, exactness and integrating factors. Variation of parameters. Picard's iteration. Ordinary linear differential equations of n-th order, solutions of homogeneous and non-homogeneous equations. Operator method. Method of undetermined coefficients and variation of parameters.

Power series methods for solutions of ordinary differential equations. Legendre equation and Legendre polynomials, Bessel equation and Bessel functions of first and second kind.

Systems of ordinary differential equations, phase plane, critical point, stability.

**Texts:**

- K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall, 1996.
- T. M. Apostol, Calculus, Volume II, 2nd Edition, Wiley, 1969.
- S. L. Ross, Differential Equations, 3rd Edition, Wiley, 1984.
- E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall, 1995.
- W.E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 7th Edition, Wiley, 2001.

**References:**

- E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley, 2005.

**ME 101 Engineering Mechanics**

**3-1-0-8**

Rigid body static: Equivalent force system. Equations of equilibrium, Free body diagram, Reaction, Static indeterminacy and partial constraints, Two and three force systems. Structures: 2D truss, Method of joints, Method of section. Frame, Beam, types of loading and supports, Shear Force and Bending Moment diagram, relation among load-shear force-bending moment.

Friction: Dry friction (static and kinematics), wedge friction, disk friction (thrust bearing), belt friction, square threaded screw, journal bearings (Axle friction), Wheel friction, Rolling resistance.

Center of Gravity and Moment of Inertia: First and second moment of area and mass, radius of gyration, parallel axis theorem, product of inertia, rotation of axes and principal M. I., Thin plates, M.I. by direct method (integration),

composite bodies. Virtual work and Energy method: Virtual Displacement, principle of virtual work, mechanical efficiency, work of a force/couple (springs etc.), Potential Energy and equilibrium, stability.

Kinematics of Particles: Rectilinear motion, curvilinear motion rectangular, normal tangential, polar, cylindrical, spherical (coordinates), relative and constrained motion, space curvilinear motion.

Kinetics of Particles: Force, mass and acceleration, work and energy, impulse and momentum, impact.

Kinetics of Rigid Bodies: Translation, fixed axis rotation, general planner motion, work, energy, power, potential energy, impulse-momentum and associated conservation principles, Euler equations of motion and its application.

#### **Texts/References:**

- I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002.
- F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II – Dynamics, 3rd Ed, Tata McGraw Hill, 2000.
- J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II – Dynamics, 5th Ed, John Wiley, 2002.
- R. C. Hibbler, Engineering Mechanics, Vol I and II, Pearson Press, 2002.
- Andy Ruina and Rudra Pratap, Introduction to Statics and Dynamics.

#### **PH 110 Physics Laboratory**

**0-0-3-3**

Instructions to Students

Introduction to Error Analysis

- Decay of Current in Capacitive Circuit
- Forced and Damped Oscillations
- Compound Pendulum
- Study of Hall Effect
- Speed of Light in Glass
- Magnetic Field along the Axis of Coil
- Fraunhofer Diffraction: Single Slit
- Velocity of Sound in Air
- Photovoltaic Effect: Solar Cell

#### **PH 102 Physics – II**

**2-1-0-6**

**Vector Calculus:** Gradient, Divergence and Curl. Line, Surface and Volume integrals. Gauss's divergence theorem and Stokes' theorem in Cartesian, Spherical polar and cylindrical polar coordinates. Dirac Delta function.

**Electrodynamics:** Coulomb's law and Electrostatic field, Fields of continuous charge distributions. Gauss's law and its applications. Electrostatic Potential. Work and Energy. Conductors, capacitors. Laplace's equation. Method of images. Dielectrics. Polarization. Bound charges. Energy in dielectrics. Boundary conditions. Lorentz force. Biot-Savart and Ampere's laws and their applications. Vector Potential. Force and torque on a magnetic dipole. Magnetic materials. Magnetization, Bound currents. Boundary conditions. Motional EMF, Ohm's law. Faraday's law. Lenz's law. Self and Mutual inductance. Energy stored in magnetic field. Maxwell's equations.

**Optics:** Huygens' principle. Young's experiment. Superposition of waves. Concepts of coherence sources. Interference by division of wavefront. Fresnel's biprism, Phase change on reflection. Lloyd's mirror. Interference by division of amplitude. Parallel film. Film of varying thickness. Colours of thin films. Newton's rings. The Michelson interferometer. Fraunhofer diffraction. Single slit, double slit and N-slit patterns. The diffraction grating.

#### **Texts:**

- D. J. Griffiths, Introduction to Electrodynamics, Prentice Hall, New Delhi, 1995.
- F. A. Jenkins and H. E. White, Fundamentals of Optics, McGraw-Hill, 1981.

#### **References:**

- R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lecture in Physics, Vol I, Narosa Publishing House, New Delhi, 1998
- I. S. Grant and W. R. Philips, Electromagnetism, John Wiley, 1990.
- E. Hecht, Optics, Addison-Wesley, 1987.

**2nd Year:**

**Third Semester:**

#### **MA 201 Mathematics – III**

**3-1-0-8**

**Complex Analysis:** Complex numbers, geometric representation, powers and roots of complex numbers. Functions of a complex variable: Limit, Continuity, Differentiability, Analytic functions, Cauchy-Riemann equations, Laplace equation, Harmonic functions, Harmonic conjugates. Elementary Analytic functions (polynomials, exponential function, trigonometric functions), Complex logarithm function, Branches and Branch cuts of multiple valued functions. Complex integration, Cauchy's integral theorem, Cauchy's integral formula. Liouville's Theorem and

Maximum-Modulus theorem, Power series and convergence, Taylor series and Laurent series. Zeros, Singularities and its classifications, Residues, Rouches theorem (without proof), Argument principle (without proof), Residue theorem and its applications to evaluating real integrals and improper integrals. Conformal mappings, Mobius transformation, Schwarz-Christoffel transformation.

**Fourier series:** Fourier Integral, Fourier series of  $2\pi$  periodic functions, Fourier series of odd and even functions, Half-range series, Convergence of Fourier series, Gibb's phenomenon, Differentiation and Integration of Fourier series, Complex form of Fourier series.

**Fourier Transformation:** Fourier Integral Theorem, Fourier Transforms, Properties of Fourier Transform, Convolution and its physical interpretation, Statement of Fubini's theorem, Convolution theorems, Inversion theorem.

**Partial Differential Equations:** Introduction to PDEs, basic concepts, Linear and quasi-linear first order PDE, Second order PDE and classification of second order semi-linear PDE, Canonical form.. Cauchy problems. D'Alemberts formula and Duhamel's principle for one dimensional wave equation, Laplace and Poisson equations, Maximum principle with application, Fourier method for IBV problem for wave and heat equation, rectangular region. Fourier method for Laplace equation in three dimensions.

**Texts:**

- R. V. Churchill and J. W. Brown, Complex Variables and Applications, 5th Edition, McGraw-Hill, 1990.
- K. Sankara Rao, Introduction to Partial Differential Equations, 2nd Edition, 2005.

**References:**

- J. H. Mathews and R. W. Howell, Complex Analysis for Mathematics and Engineering, 3rd Edition, Narosa, 1998.
- I. N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1957.
- E. Kreyszig, Advanced Engineering Mathematics, 5th / 8th Edition, Wiley Eastern / John Wiley, 1983/1999.

**CS 201 Object Oriented Programming and Data Structures**

**3-0-3-9**

From C to Java: basics of Java, introduction to the object oriented programming (OOP) concepts (such as classes, objects, constructors, destructors, inheritance, polymorphism, operator overloading) using Java, JVM, applets, APIs, GUI Programming. From Java to C++: the OOP concepts using C++. Performance of algorithms: space and time complexity, asymptotics. Fundamental Data structures: linked lists, arrays, matrices, stacks, queues, binary trees, tree traversals. Algorithms for sorting and searching: linear search, binary search, insertion-sort, bubble-sort, quicksort. Priority Queues: lists, heaps. Graphs: representations, depth first search, breadth first search. Hashing: separate chaining, linear probing, quadratic probing. Search Trees: binary search trees, red-black trees, AVL trees, splay trees, B-trees.

**Texts:**

- M. A. Weiss, Data Structures and Problem Solving Using Java, 2nd Ed, Addison-Wesley, 2002.
- T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, MIT Press, 2001.

**References:**

- B. W. Kernighan and D. Ritchie, The C Programming Language, 2nd Ed, Prentice Hall of India, 1988.

**CE 201 Introduction to Materials and Solid Mechanics**

**3-0-0-6**

**Introduction to Materials:** structure and properties (mechanical, thermal, magnetic, optical, electrical and electronic) of materials relevant to practicing engineers (i.e., primarily metals, ceramics, polymers and composites). Crystal structure and imperfection in metals. Diffusion mechanical properties and failure mechanisms. Phase equilibrium diagrams and heat treatment principles for steels, cast irons, and aluminum alloys. Introduction to High-performance materials and Nanomaterials. Material selection and engineering applications.

**Introduction to Stress and strain:** Definition of Stress, Normal Stress in axially loaded Bar, Stress on inclined sections in axially loaded bar, Shear Stress, Analysis of normal and shear stress, Deterministic design of members, probabilistic basis for structural design. Tension test and normal Strain, Stress strain relation and Hooke's law. Poisson's ratio, Thermal strain and deformation.

**Stress as a tensor:** stress at point, Cauchy stress tensor, equilibrium equations, analysis of deformation and definition of strain components,

**Compatibility relations:** One-to-one deformation mapping, invertibility of deformation gradient, Compatibility condition.

**Some properties of Stress and Strain Tensor:** Principal stresses and strains, stress and strain invariants, Mohr's circle representation.

**Constitutive relations:** An short introduction to material symmetry transformations, Isotropic material, true and engineering stress-strain curves, Material properties for isotropic materials and their relations. Theories of failures for isotropic materials.

**Application of Mechanics of Material in Different Problems:**

- Shear Force and Bending Moment diagrams.
- Axially loaded members.
- Torsion of circular shafts.
- Stresses due to bending: pure bending theory, combined stresses. Deflections due to bending: moment-curvature relation, load-deflection differential equation, area moment method, and superposition theorem.
- Stresses and deflections due to transverse shears.

**Energy Methods:** Strain energy due to axial, torsion, bending and transverse shear. Castigliano's theorem, reciprocity theorem etc.

**Texts and References:**

- D. Callister, D. G. Rethwisch, Materials Science and Engineering: An Introduction, 8<sup>th</sup> Ed., John Wiley and Sons, New York, 2010.
- J. F. Shackelford, Introduction to Materials Science for Engineers, 5<sup>th</sup> Ed., New York: Prentice Hall, Inc., 2000.
- S. C. Crandall, N. C. Dahl, and T. J. Lardner, An Introduction to the Mechanics of Solids, 2nd Ed, McGraw Hill, 1978.
- E. P. Popov, Engineering Mechanics of Solids, Prentice Hall, 1990.
- I. H. Shames, Introduction to Solid Mechanics, 2nd Ed, Prentice Hall, 1989.
- S. P. Timoshenko, Strength of Materials, Vols. 1 & 2, CBS publ., 1986.

**CE 203 Geomatics Engineering**

**3-0-0-6**

Introduction to surveying; linear measurements; chain surveying; compass surveying; accuracy, precision and errors, leveling; plane table; contouring, theodolite surveying, tacheomatic survey; trigonometrical surveying; triangulation; curves; advanced survey instruments; Electronic Distance Measurement, Total station and Global Positioning System, Introduction to photogrammetry and remote sensing.

**Texts/References:**

- T. P. Kanetkar and S. V. Kulkarni, Surveying and Levelling, Vol-I and Vol-II, Pune Vidyarthi Griha Prakshan, 1972.
- B. C. Punmia, A.K. Jain & A.K. Jain, Surveying, Vol-I and Vol-II, Laxmi Publication Pvt., 1996.
- T.M. Lillesand and R.W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, 1994.
- G. W. Schofield, Engineering Surveying, Butterworth, Heinemann, New Delhi, 2001.
- G. Joseph, Fundamentals of Remote Sensing, Universities Press, 2003.

**CE 205 Fluid Mechanics and Hydraulics**

**3-0-0-6**

Fluid properties; Pressure measurement; Hydrostatic forces on plane and curved surfaces; Buoyancy and equilibrium; Stability, metacentric height; Types of flow; Continuity; Energy and momentum equations; Velocity distribution and velocity coefficients, practical applications; Navier-Stoke equation; Shear stress and pressure gradient; Flow through pipes, Hagen-Poiseuille equation; Turbulence, Prandtl's mixing length, eddy viscosity; Darcy-Weisbach equation for flow through pipes, friction factor, Moody diagram, minor losses, pipes in series and parallel, equivalent length, pipe network analysis; Water hammer; Boundary layer concept, drag coefficients, control of boundary layer; Dimensional analysis and similitude, Open channel hydraulics, uniform flow, critical flow, Gradually varied flow, hydraulic jump, unsteady flow; Introduction to pumps and turbines; Channel design, erodable and non-erodable channels, silt theories, sediment transport; Introduction to river engineering, meandering, river training works

**Texts:**

- V.L. Streeter and E.B. Wylie, Fluid Mechanics, McGraw Hill, 1997.
- P.N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House, 1998.
- V.T. Chow, Open Channel Flow, McGraw Hill, 1975.
- S.K. Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 1992.

**References:**

- B. F. White, Fluid Mechanics, McGraw Hill, 1994.
- K. S. Massey, Mechanics of Fluids, Van Nostrand Reinhold Co., 1979.
- J. Frabzini, Fluid Mechanics with Engineering Applications, McGraw Hill, 1997.
- J.H. Spurk, Fluid Mechanics – Problems and Solutions, Springer, 2003.
- H.M. Chaudhry, Open Channel Flow, Prentice Hall of India, 1998.
- K. Subramanya, Flow in Open Channels, Tata McGraw Hill, 1998.
- B.C. Punmia, Irrigation and Water Power Engineering, Standard Publishers, 1992.

**CE 207 Fluid Mechanics and Hydraulics Laboratory**

**0-0-3-3**



Measurement of fluid pressure using various manometers and gauges, Experimental study on capillarity, Determination of coefficient of viscosity of a fluid using viscometer, Experimental study on stability of floating bodies, Study on fluid pressure distribution on immersed bodies, Study of different types of flow using Reynold's apparatus, Determination of friction factor in pipes using pipe friction apparatus, Experimental study on flow nets using Hele-Shaw apparatus, Experimental study on cavitations, Study of flow behavior in open channels using tilting flume, Determination of resistance coefficient in open channels, Experimental study on variation of specific energy with depth of flow in open channels, Measurement of flow using weirs and notches, Measurement of flow using a Parshall flume, Experiments on gradually varied flow (GVF) in open channels, Experimental study on hydraulic jumps, Experimental studies on centrifugal and reciprocating pumps, Experimental studies on impulse and reaction turbines.

#### **Texts/References:**

- P. N. Modi and S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House, 1998.
- K. L. Kumar, Engineering Fluid Mechanics, Eurasia Publishing Company (P) Ltd., New Delhi, 1999.

#### **HS 201 Introductory Microeconomics**

**3-0-0-6**

**Introduction:** Why Economics, The Central Economic Problem, Production Possibility Curve (PPC)

**Overview of Markets:** Demand and Supply, Elasticity, Efficiency and Equity, Markets in Action

**Determinants of Demand and Supply:** Utility and Demand, Production and Costs

**Markets for Goods and Services:** Competition, Monopoly, Monopolistic Competition and Oligopoly

**Markets and Government:** Externalities, Public Goods and Taxes, Factor markets, Income distribution

#### **Texts:**

- Paul A. Samuelson and William Nordhaus, Economics, Tata M.Hill, 2005.

#### **References:**

- A. Koutsoyiannis, Modern Microeconomics, Macmillan, 2008.
- Richard G. Lipsey and Alec Chrystal, Economics, Oxford, 2007.
- Microeconomics: An Integrated Approach, David Besanko and Ronald R. Braeutigam, John Wiley and Sons, 2002.

#### **HS 221 Fundamentals of Linguistics Science**

**3-0-0-6**

**Introduction:** Language; Linguistics; Language Learning

**Phonetics (Sound Systems):** Mechanism of Speech Production, Consonants, Vowels, Phonotactic Rules, Phonology: Phonemes

**Morphology:** Morphemes, Structure of Words,

**Syntax:** Constituents of a Sentence, Structure of a Sentence; Grammar; Acceptability and Grammaticality; Principles and Parameters; Prescriptive, Descriptive, and Explanatory Adequacy, Syntactic Tools; Principles of modern linguistics with special reference to English and Hindi syntax

**Use of language:** Language in Literature, Media, Language in Advertisement

**Sociolinguistics:** Language is Social Context; Multilingualism

**Language and Politics:** Language in Constitution; Language and Dialect

**Psycholinguistics:** Language Acquisition; Universal Grammar Semantics, Language Change and Language Variation, Language and Computers

#### **Text and References:**

- Bloomfield, L. 1933 Language, pp. 21-41. Holt, Rinehart and Winston
- Chomsky, N. 1965 Aspects of the Theory of Syntax, pp. 3-15, 18-27, 47-59. MIT Press
- Farmer, Ann and Richard Demers 2001 A Linguistics Workbook MIT Press

#### **HS 231 Introductory Sociology**

**3-0-0-6**

**Introduction:** Sociological Imagination; Subject matter of Sociology.

**Theoretical Practice:** Durkheim (Foundations of the Science of Society), Weber (Economy and Society), Marx (Political Economy), Foucault (Practices and Knowledge), Butler (Gender Performativity), & Burawoy (Public Sociology).

**Methodology and Methods:** Qualitative, Quantitative, and Mixed

**Indian Society:** Eminent Indian Sociologists; Caste, Class, and Tribe; Women and Children; Health and Education; Science, Technology and Society; Media and Migration; Globalization and Social Change; Diaspora; Bihar- a case study.

#### **Text and References:**

- Alex Inkeles, What is Sociology? An Introduction to the Discipline and Profession New Delhi: Prentice-Hall of India, 1997
- Anthony Giddens, Sociology (Sixth Edition) Cambridge: Polity Press, 2009

- M.N.Srinivas, Social Change in Modern India, New Delhi: Orient Longman, 1985
- S. C. Dube, Indian Village London: Routledge, 1955.

**Fourth Semester:**

**CE 202 Structural Analysis**

**3-1-0-8**

Indeterminate structures, Strain energy, work done by forces, Total strain energy, Minimum potential energy, Minimum complementary energy, Castigliano's theorems, Displacement method: Joint displacement method for trusses, slope displacement method for beams and frames, Force/ compatibility method: Unit load method; Application to indeterminate trusses and frames; Matrix method.

**Texts:**

- C.S. Reddy, Basic Structural Analysis, Second Edition, Tata McGraw Hill, 2005.
- R.C. Hibbeler, Structural Analysis, Pearson Education, 6th edition, 2009.
- W. Weaver and J. M. Gere, Matrix analysis of framed structures, CBS Publishers, 2nd edition, 2004.
- C.K. Wang, Intermediate Structural Analysis, Tata McGraw Hill, 1984.

**References:**

- D.S. Prakash Rao, Structural analysis: Unified approach, Universities Press, 1996.
- C.H. Norris, J.B. Wilbur, S.Utku, Elementary Structural Analysis, Tata McGraw Hill, 4th edition, 2003.
- L. S. Negi and R. S. Jangjid, Structural Analysis, Tata Mc. Graw, New Delhi, 1997.
- G.S. Pandit and S.P. Gupta, Structural Analysis - A matrix approach, Tata McGraw Hill, 2<sup>nd</sup> edition, 2008.
- M.B. Kanchi, Matrix Methods of Structural analysis, Enlarged edition, Wiley Eastern Limited, 1993.

**CE 204 Irrigation and Flood Control Engineering**

**3-0-0-6**

Importance of irrigation, Sources and quality of irrigation water, Soil-water-plant relationship, Crop water requirements, Consumptive use and estimation of irrigation, Methods of irrigation, Water requirements, Design of irrigation, Canal system, Irrigation structures, Diversion headwork, Cross drainage work, Irrigation pumps, Problems of irrigation land, Water logging, Flood and its control.

**Texts/References:**

- Bharat Singh, Fundamentals of Irrigation Engineering, Nem Chand & Brothers, Roorkee, 1975.
- Orson W. Israelsen, Vaughn E. Hansen and Glen E. Stringham, Irrigation Principles and Practices, John Wiley & Sons Inc, 4th edition, 1980.
- K.R. Arora, Irrigation Water Power and Water Resources Engineering, Standard Publishers Distributors, Delhi, 2002.
- G.L. Asawa, Elementary Irrigation Engineering, New Age International (P) Ltd., New Delhi, 1999.

**CE 206 Introduction to Soil Mechanics and Foundation Engineering**

**3-0-0-6**

Review of geotechnical problems in civil and infrastructure engineering, Origin and classification of soils; Index properties of soil, Effective stress principle, Permeability of soil (soil - water systems - capillarity, flow, darcy's law, permeability, and tests for its determination, different heads, piping, quicksand condition), Stresses within soil, Shear strength of soil (Mohr - Coulomb strength criterion, direct and triaxial shear tests, drained, consolidated drained and undrained tests, NC and OC soils, dilation, pore pressures, Skempton's coefficients), Compaction (characteristics, water content - dry unit weight relationships, OMC, maximum dry unit weight, field compaction, quality control), Compressibility and consolidation characteristics (over consolidation ratio, determination of coefficients of consolidation and secondary compression, consolidation under construction loading), Settlement analysis (settlements, tilt and rotation of foundations, immediate settlement, elastic theories, consolidation and creep settlements), Foundations classification (types of foundations, selection and uses), Shallow foundation (general requirement for satisfactory performance of shallow foundations, bearing capacity, general, local and punching shear failures, corrections for size, shape, depth, water table, compressibility), Deep foundation (selection of piles, bearing capacity of piles).

**Texts:**

- V. N. S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, Taylor & Francis Group, First Indian Reprint, 2010.
- H. G. Poulos, and E. H. Davis, Pile Foundation Analysis and Design, Krieger Pub Co., 1990.

**References:**

- Gopal Ranjan, and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2<sup>nd</sup> Edition 2000.
- R. F. Craig, Craig's Soil Mechanics, Taylor & Francis Group, 7th Edition, 2004.
- K. Terzaghi, R. B. Peck and G. Mesri, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1996.

- J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.

### **CE 208 Numerical Methods for Civil and Infrastructure Engineering**

**3-0-0-6**

**Introduction to Numerical Methods:** objectives of numerical methods, sources of error in numerical solutions: truncation error, round off error, order of accuracy - Taylor series expansion

**Direct Solution of Linear systems:** Gauss elimination, Gauss Jordan elimination. Pivoting, inaccuracies due to pivoting. Factorization, Cholesky decomposition. Diagonal dominance, condition number, ill conditioned matrices, singularity and singular value decomposition. Banded matrices, storage schemes for banded matrices, skyline solver.

**Iterative solution of Linear systems:** Jacobi iteration. Gauss Seidel iteration. Convergence criteria.

**Direct Solution of Non Linear systems:** Newton Raphson iterations to find roots of a 1D nonlinear equation. Generalization to multiple dimensions. Newton Iterations, Quasi Newton iterations. Local and global minimum, rates of convergence, convergence criteria.

**Iterative Solution of Non Linear systems:** Conjugate gradient. Preconditioning.

**Partial Differential Equations:** Introduction to partial differential equations. Definitions & classifications of first and second order equations. Examples of analytical solutions. Method of characteristics.

**Numerical Differentiation:** Difference operators (forward, backward and central difference). Stability and accuracy of solutions. Application of finite difference operators to solve initial and boundary value problems.

**Introduction to the Finite Element Method as a method to solve partial differential equations:** Strong form of the differential equation. Weak form. Galerkin method: the finite element approximation. Interpolation functions: smoothness, continuity, completeness, Lagrange polynomials. Numerical quadrature: Trapezoidal rule, simpsons rule, Gauss quadrature.

**Numerical integration of time dependent partial differential equations:** Parabolic equations: algorithms - stability, consistency and convergence, Lax equivalence theorem. Hyperbolic equations: algorithms – Newmark's method, stability and accuracy, convergence, multi-step methods.

**Numerical solutions of integral equations:** Types of integral equations. Fredholm integral equations of the first and second kind. Fredholm's Alternative theorem. Collocation and Galerkin methods for solving integral equations.

**Applicability of Numerical Methods in Civil and Infrastructure Engineering**

**Exposure to software packages like MATLAB**

#### **Texts / References:**

- S. Chapra and R. Canale, Numerical Methods for Engineers, 6th Ed., McGraw Hill, 2010.
- S. Guha and R. Srivastava, Numerical Methods: For Engineering and Science, 1<sup>st</sup> Ed., Oxford University Press, 2010.
- D. Dahlquist, and A. Bork, Numerical Methods, Prentice-Hall, Englewood Cliffs, NJ, 1974.
- K. E. Atkinson, Numerical Analysis, John Wiley, Low Price Edition, 2004.
- J. D. Hoffman, Numerical Methods for Engineers and Scientists, McGraw-Hill, 2001.
- S. C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill 2008.

### **CE 210 Soil Mechanics Laboratory**

**0-0-3-3**

Determination of field density of soil by sand replacement & core cutter methods, Specific gravity & relative density determination, Grain size distribution by sieve and hydrometer analysis, Atterberg limits, Compaction properties of soil, Permeability of soil, C. B. R, Direct shear test, Triaxial test, Demonstration for soil exploration techniques (SPT, CPT, etc.)

#### **Texts/References:**

- J. Bardet, Experimental Soil Mechanics, Upper Saddle River, Prentice Hall, USA, 1992.
- D. Fratta, J. Aguetant, and L. R. Smith, Soil Mechanics Laboratory Testing, Boca Raton, CRC Press, USA, 2007.

### **CE 212 Geomatics Engineering Laboratory**

**0-0-3-3**

Tapes, Chains, Setting out of Buildings, Theodolite, Leveling and Dumpy level, Plain table survey, tacheometry and trigonometric leveling, Triangulation and correction of errors, Total station, Contours, Layout of transition curves, Computation of earth work, Geodetic survey.

#### **Texts/References:**

- B.C. Punmia, A.K. Jain and A.K. Jain, Surveying, Vol. 1 and II, Laxmi Publications (P) Ltd., New Delhi, 1996.
- K.R. Arora, Surveying, Vol. I and II, Standard Book House, Delhi, 1998.

### **HS 202 Introductory Macroeconomics**

**3-0-0-6**

Introduction: Alternative Economic Systems, Government and the Markets, Supply and Demand in Macroeconomics, Aggregate Demand and Supply, Macroeconomic Issues: Measuring the Economy, Economic Growth, Macroeconomics and Income, Aggregate Expenditures, Fiscal Policy, Inflation, Unemployment and Employment, Money and Banking: Money Creation, Monetary Policy, Role of Money in Macroeconomics, Commercial and Central Bank, International Trade: International Trade, Trade and International Currency, Balance of payments and exchange rate, Exchange Rates and Their Effects.

**Texts:**

- P. A. Samuelson and W. Nordhaus, Economics, Tata M.Hill, 2005
- M.L. Jhingan, Macroeconomic Theory, Konark Publishers Pvt. Ltd, 2008

**References:**

- A. B. Abel, B.S. Bernanke, Macroeconomics, Addison Wesley, 2000
- P.R. Krugman & M. Obstfeld, International Economics: Theory and Policy, Pearson Education (Singapore) Indianbranch, Delhi, 2008

**HS 211 Literature: Voices and Cultures**

**3-0-0-6**

Identity and diversity of culture, Concepts - ideology, power, hegemony. The voice of suppressed women in Charlotte Bronte's 'Jane Eyre', the appearance of the independent woman in 'Jane Eyre', woman-woman relationship in 'Kamala', challenging patriarchy in 'Kamala', Violence and Racism in Alice Walker's 'The Colour Purple', Disruption of traditional roles in 'The Colour Purple', The voice of the underdogs in 'Untouchable', the female voice in 'Untouchable', laws and human behaviour in 'The God of Small Things', hierarchies in 'Indian Society' in 'the God of Small Things', the voice of the Black women in Phillis Wheatley's 'On Being Brought from Africa to America' and A. Ruth's 'A Black Woman, Nothing Else', the voice of the powerless in Langston Hughes 'Ballad of the Landlord'.

**Texts:**

- Charlotte Bronte, Jane Eyre, Macmillan India, 2000.
- Krupabai Sathianadhan, Kamala, OUP, 1998.
- Alice Walker, The Colour Purple, Houghton Mifflin Harcourt, 2006.
- Mulk Raj Anand, Untouchable, Penguin Classics, 1990.
- Arundhati Roy, The God of Small Things, Penguin, 2002.
- Phillis Wheatley, On Being Brought From Africa to America. (Phillis Wheatley, Poems on Various Subjects, Religious and Moral (London: by A. Bell, for Cox and Berry, Boston, 1773): 18).
- A. Ruth, A Black Woman, Nothing Else, Author's Den, 2002.
- Hughes Langston, Ballad of the Landlord, The Langston Hughes Reader, George Braziller, New York, 1958.
- (The poems mentioned shall be provided in the class)

**References:**

- Meenakshi Mukherjee, Elusive Terrain: Culture and Literary Memory, OUP, New Delhi, 2008.
- Malashri Lal, Signifying the Self – Women and Literature, Macmillan India, New Delhi, 2004.
- Sachchidanand Mohanty, Gender and Cultural Identity, Orient Black Swan, New Delhi, 2008.
- Nandy Bhatia, Acts of Authority/ Acts of Resistance, OUP, 2004.
- N Krishnaswamy, Contemporary Literary Theory, Macmillan, New Delhi, 2005.

**HS 223 Cognition: Language and Computation**

**3-0-0-6**

Language: Study of language as a rule governed system (Structure of Language), Acquisition of language, Universal Grammar, Knowledge of Language; Cognitive Science: Introduction, Study of Human Mind, Language and Human Mind, Language as a Cognitive Behavior; Cognitive Computation: Formal Models of Computation, Church-Turing Thesis, Chomsky/Machine Hierarchy; Human Cognition as Computation: Cognitive Architecture, Production System Architecture, Problem Spaces, Protocol Analyses; Artificial Intelligence and the Design of Intelligent Systems: Physical Symbol System Hypothesis, Representation and Semantics, General Models of Search, Knowledge & Search, Computational Limits and Rationality.

**Texts:**

- N. Chomsky, New horizons in the study of language and mind, Cambridge University Press, 2000
- N. Chomsky, Knowledge of language: its nature, origin, and use Convergence Greenwood Publishing Group, 1986
- P. Thagard, Mind: Introduction to Cognitive Science, MIT Press, 2005
- W. Croft and D.A. Cruse, Cognitive linguistics, Cambridge University Press, 2004
- S. Jonathan Russell Artificial intelligence: a modern approach, Prentice-Hall Of India Pvt. Ltd., 2008

- R. Morelli, W. Miller Brown, D. Anselmi, K. Haberiandt, and D. Lloyd (Eds.) *Minds, Brains and Computers: Perspectives in Cognitive Science and Artificial Intelligence*, Intellect Books, 1992

**References:**

- W. Bechtel, G. Graham (Eds.), *A Companion to Cognitive Science*, Wiley-Blackwell, 1999
- J. Friedenbergl and G. Silverman, *Cognitive Science: An Introduction to the Study of Mind*, SAGE, 2005
- J. P. Heuristics, *Intelligent Search Strategies for Computer Problem Solving*, Addison-Wesley Pub. Co., 1984

**CH 201 Green Chemistry and Technology**

**3-0-0-6**

Principles and Concepts of Green Chemistry: Sustainable development, atom economy, reducing toxicity. Waste: production, problems and prevention, sources of waste, cost of waste, waste minimization technique, waste treatment and recycling. Catalysis and Green Chemistry: Classification of catalysts, heterogeneous catalysts heterogeneous catalysis, biocatalysis. Alternate Solvents: Safer solvents, green solvents, water as solvents, solvent free conditions, ionic liquids, super critical solvents, fluoruous biphasic solvents. Alternative Energy Source: Energy efficient design, photochemical reactions, microwave assisted reactions, sonochemistry and electrochemistry. Industrial Case Studies: Greening of acetic acid manufacture, Leather manufacture (tanning, fatliquoring), green dyeing, polyethylene, ecofriendly pesticides, paper and pulp industry, pharmaceutical industry. An integrated approach to green chemical industry.

**Text:**

- V. K. Ahluwalia, *Green Chemistry: Environmentally Benign Reactions*, Ane Books India, New Delhi, 2006.
- M. M. Srivastava, R. Sanghi, *Chemistry for Green Environment*, Narosa, New Delhi, 2005.

**Reference:**

- P. T. Anastas and J.C. Warner, *Green Chemistry, Theory and Practice* Oxford, 2000.
- M. Doble and A. K. Kruthiventi, *Green Chemistry and Engineering*, Academic Press, Amsterdam, 2007.
- Mike Lancaster, *Green Chemistry: An Introductory Text*, Royal Society of Chemistry, 2002.
- R. E. Sanders, *Chemical Process Safety: Learning from Case Histories*, Butterworth Heinemann, Boston, 1999.

**MA 214 Introduction to Computational Topology**

**3-0-0-6**

**Introduction and general notions of point set topology:** Open and Closed Sets, Neighbourhoods, Connectedness and Compactness, Separation, Continuity.

**An overview of topology and classification of surfaces:** Surfaces – orientable and non-orientable, their topology, classification of closed surfaces.

**Combinatorial Techniques:** Simplicial complexes, and simplicial maps, triangulations, Euler characteristics, Maps on surfaces.

**Homotopy and Homology Groups:** Introducing Groups and concept of Homotopy, fundamental group and its calculations, Homology.

**Calculating Homology:** Computation of homology of closed surfaces.

**Topics in Geometry:** Delauny triangulations, Voronoi diagrams, Morse functions.

**Texts:**

- Afra Zomordian: *Topology for Computing*, CUP, 2005
- H. Edelsbrunner and J. Harer. *Computational Topology. An Introduction*. Amer. Math. Soc., Providence, Rhode Island, 2009
- J. J. Rotman: *An introduction to Algebraic Topology*, GTM- 119, Springer, 1998

**References:**

- Tomasz K., K. Mischaikow and M. Mrozek, *Computational Homology*, Springer, 2003
- H. Edelsbrunner, *Geometry and Topology for Mesh Generation*, CUP, 2001
- D. Kozlov, *Combinatorial Algebraic Topology*, Springer, 2008
- V. A. Vassiliev, *Introduction to Topology*, AMS, 2001
- R. Messer and P. Straffin, *Topology Now*, MAA, 2006

**MA 251 Optimization Techniques**

**3-0-0-6**

Introduction to linear and non-linear programming. Problem formulation. Geometrical aspects of LPP, graphical solution. Linear programming in standard form, simplex, Big M and Two Phase Methods. Revised simplex method, special cases of LP. Duality theory, dual simplex method. Sensitivity analysis of LP problem. Transportation, assignment and traveling salesman problem.

Integer programming problems-Branch and bound method, Gomory cutting plane method for all integer and for mixed integer LP. Theory of games: Computational complexity of the Simplex algorithm, Karmarkar's algorithm for LP. Unconstrained Optimization, basic descent methods, conjugate direction and Newton's methods. Acquaintance to Optimization softwares like TORA.

**Texts:**

- Hamdy A. Taha, Operations Research: An Introduction, Eighth edition, PHI, New Delhi (2007).
- S. Chandra, Jayadeva, Aparna Mehra, Numerical Optimization with Applications, Narosa Publishing House (2009).
- A. Ravindran, Phillips, Solberg, Operation Research, John Wiley and Sons, New York (2005).
- M. S. Bazaraa, J. J. Jarvis and H. D. Sherali, Linear Programming and Network Flows, 3rd Edition, Wiley (2004).

**References:**

- D. G. Luenberger, Linear and Nonlinear Programming, 2nd Edition, Kluwer, 2003. S. A. Zenios (editor), Financial Optimization, Cambridge University Press (2002).
- F. S. Hiller, G. J. Lieberman, Introduction to Operations Research, Eighth edition, McGraw Hill (2006).

**3rd Year:  
Fifth Semester:**

**CE 301 Design of Reinforced Concrete Structures**

**3-1-0-8**

Scope, stress-strain relation of concrete, Assumptions -- Codes of practice, factor of safety – Role of reinforcement – Bond between steel and concrete – Development of micro-crack and formation of isolated cracks – Theories of failure of concrete -- Design of simply supported and continuous beams with rectangular cross sections – T- and L-beams – Design of columns under uniaxial and biaxial bending – Design of slabs – Design of walls – Design of common RCC structures: Portal frames, staircases, overhead water tanks, etc. – comments.

**Texts:**

- S. U. Pillai and D. Menon, Reinforced Concrete Design, Tata McGraw-Hill 3rd edition, 2009.
- P. C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall India, 2008.

**References:**

- S. N. Sinha, Reinforced Concrete Design, Tata McGraw-Hill, 2nd Edition, 2002.
- M. L. Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall India, 2006.
- A. K. Jain, Reinforced concrete: Limit state design, Nem Chand and Bros. 1999.
- J. Macgregor and J. K. Wight, Reinforced Concrete: Mechanics and Design, Prentice Hall, 5<sup>th</sup> edition, 2008.
- R. Park and T. Paulay, Reinforced Concrete Structures, John Wiley and Sons, 1975.

**CE 303 Water Supply and Wastewater Engineering**

**3-0-0-6**

General requirement for water supply, sources, quality and quantity of water, intake, pumping and transportation of water; Physical, chemical and biological characteristics of water and their significance, Water quality criteria, Water borne diseases, Natural purification of water sources, Engineered systems for water treatment: aeration, sedimentation, softening, coagulation, filtration, adsorption, ion exchange, and disinfection. Water distribution system, Generation and collection of wastewater, sanitary, storm and combined sewerage systems, Quantities of sanitary wastes and storm water, Design of sewerage system, Primary, secondary and tertiary treatment of wastewater; Wastewater disposal standards, Basics of microbiology, Biological wastewater treatment systems: Aerobic processes - activated sludge process and its modifications, trickling filter, Anaerobic Processes - conventional anaerobic digester, High rate and hybrid anaerobic reactors, Wastewater recycling and reuse and associated infrastructure, Sludge digestion and handling, Rural water supply and sanitation, Visit to water and wastewater treatment plants.

**Texts:**

- H. S. Peavy, D. R. Rowe and George Tchobanoglous, Environmental Engineering, McGraw-Hill International Ed., 1985.
- T. J. McGhee, Water Supply and Sewerage, McGraw-Hill Inc., 1991.

**References:**

- M. L. Davis and D. A. Cornwell, *Introduction to Environmental Engineering*, McGraw-Hill, Inc., 1991.
- Metcalf & Eddy, *Wastewater Engineering- Treatment and Reuse* (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4th Edn., 2004.

- C. N. Sawyer, P. L. McCarty and G. F. Parkin, *Chemistry for Environmental Engineers*, McGraw- Hill, 1994.
- APHA, *Standard Methods Examination of Water and Wastewater*, American Public Health Association, Washington DC, 1995.
- *Manual for Sewer and Sewerage*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1993.
- *Manual for Water Supply and Treatment*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

### **CE 305 Transportation Engineering**

**3-0-0-6**

Introduction to Transportation Engineering; Vehicle and driver characteristics; Pavement materials and characterization: subgrade soil, aggregates, bituminous and modified binders; Pavement analysis and design: Flexible pavements, Rigid pavements; Geometric design of Highways: Cross sectional elements, Horizontal alignment, Vertical alignment; Highway Construction, Highway Maintenance, Evaluation of Transportation Improvement. Analysis of Traffic Flow, Design of Traffic facilities.

#### **Texts:**

- P. Chakroborty and A. Das, *Principles of Transportation Engineering*, Prentice Hall India, 2003.
- S.C. Saxena and S.P. Arora, *A text book of Railway engineering*, Dhanpat Rai, 2001.

#### **References:**

- C. J. Khisty and B. K. Lall, *Transportation Engineering: an introduction*, Prentice Hall India, 2003.
- F. L. Mannering, W. P. Kilareski, and S.S. Washburn, *Principles of Highway engineering and traffic analysis*, John Wiley and Sons, 2005.
- C. S. Papacostas and P. D. Prevedouros, *Transportation Engineering and Planning*, Prentice Hall India, 2001.
- J. H. Banks, *Introduction to Transportation Engineering*, McGraw-Hill, 2002.
- N. A. Harold, *Highway materials, Soil and Concrete*, Prentice Hall, 2004.
- S. K. Khanna and C. E. G. Justo, *Highway Engineering*, Nem Chand Bros., 2002.
- Y. H. Huang, *Pavement Analysis and Design*, Pearson Education, India 2008.

### **CE 307 Construction Planning and Management**

**3-0-0-6**

Construction as industry and its challenges, Role of construction management, Methods of construction managements, Basic requirements of construction management: Learning structures, Life cycle of construction projects: Examples of real projects and its learning requirements, Stages of awarding contract, types of contract, contract documents, arbitration and settlement of disputes, contract laws and handling of contracts, commissioning of project, Principles of estimation, Principles of general and detailed specifications, Site organization; Layout; Work study; Decision making processes; CPM and project monitoring; Maintenance management; Introduction to network based project management techniques: Defining activities and their interdependence, drawing of network, time and resource estimations, use of network as scheduling techniques, use of network as control techniques i.e. project monitoring, Construction Technology: construction of superstructure and substructures, Various construction methods: Excavation, Earth-moving, Drilling, Blasting, Dewatering, foundation, Finishing items, painting, flooring, brick works. Examples of construction of structures such as buildings, bridges, roads, tunnels, industrial structures, Quality Management and Construction safety, Use of information technology in construction industries, Automation in construction industry: a general discussion.

#### **Texts:**

- F. Harris, R. McCaffer and F. Edum-Fotwe, *Modern Construction Management*, Blackwell Publishing, 2006.
- C. J. Schexnayder and R. E. Mayo, *Construction Management Fundamentals*, McGraw Hill, New Delhi, 2003.

#### **References:**

- J. Singh, *Heavy Constructon-Planning, equipment and methods*, Oxford & IBH Publishing Co. Pvt 1993.
- R.L. Peurifoy and C.J. Schexnayder, *Construction planning and equipment, and methods*, Sixth edition, Tata McGraw-Hill, 2006.
- D.S. Berrie and B.c. Paulson, *Professional construction management including C.M., Design construct and general contracting*, Third edition, McGraw Hill International edition, 1992.
- L.S. Srinath, *PERT and CPM principles and Applications*, Third edition, Affiliated east-west press Pvt Ltd, 2001.
- D.G. Carmichael, *Construction engineering Networks: Techniques, planning and management*, Ellis Horwood Publishers Chichester 1989.

- K.K. Chitkara, Construction project management: planning, scheduling and controlling, Tata McGraw-Hill, 2008.

### **CE 309 Building Design, Estimation & Construction**

**2-0-3-7**

Architectural requirement of building, Components of buildings: plan, elevation and section of buildings; Drawing of various details of residential buildings; Types of building: residential, industrial; brick masonry, Municipal codes, Estimation: types of estimates, Central line method, short wall - long wall method, Modes of measurement, estimation of buildings, Specifications and analysis of rates, Different construction materials: bricks; aggregates; cement; concrete; steel; fiber-reinforced plastic (FRP) and others; Construction methodologies and equipments.

#### **Texts/References:**

- B. N. Dutta, Estimating and Costing, Tagor Palli, Lucknow, 1991.
- G. H. Cooper, Building Construction and Estimating, McGraw-Hill, 1971.
- S. Somayaji, Civil Engineering Materials, Prentice Hall, New Jersey, 2001.
- M. S. Mamlouk and J. P. Zaniewski, Materials for Civil and Construction Engineers, Pearson, Prentice Hall, Second edition, 2006.
- A. M. Neville and J. J. Brooks, Concrete Technology, Pearson Education, Fourth Indian reprint, 2004.
- N. Jackson and R. K. Dhir, Civil Engineering materials, Macmillan Fourth edition 1997.
- M. S. Shetty, Concrete Technology, S. Chand and Company Ltd. 2005.
- P. C. Aitcin, High Performance Concrete, E & Fn Spon, 1998.
- J. F. Shackelford and M. K. Muralidhara, Introduction to Material science for Engineers, Pearson Education, Sixth edition, 2007.

### **CE 311 Structural Laboratory**

**0-0-3-3**

Composition of Concrete – Behavior of green concrete – behavior of hardened concrete - Types and roles of reinforcement,

Lab. 1: Bending of Bars and preparation of reinforcement cage

Lab. 2: Making formwork and casting of a RCC beam

Lab. 3: Tests on fine aggregate: Fineness modulus, Moisture content and SSD condition, Unit weight and bulking of sand

Lab. 4: Coarse aggregate: Fineness of coarse aggregate

Lab. 5: Tests of cement: Normal consistency, Initial and Final Time of set, Preparation of standard cubes to determine compressive strength of concrete, durability test

Lab. 6: Mix Design- I

Lab. 7: Mix design – II

Lab. 8: Admixtures of Concrete and their effects

Lab. 9: Behavior of Concrete under 2- and 3-dimensional Stress

Lab. 10: Behavior of Steel Beams

Lab. 10: Introduction to Dynamic Effects

Lab. 11: Other important Considerations: Stress concentration, Repeated loading, Measurement of stresses; etc.

Lab. 12: Viva- voce

#### **Texts/References:**

- A. M. Neville and J. J. Brooks, Concrete Technology, Pearson Education, Fourth Indian reprint, 2004.
- A. Ghali, A. Neville and T.G. Brown, Structural Analysis, Spon Press, 3 edition, 1990.

### **CE 313 Transportation Engineering Laboratory**

**0-0-3-3**

Laboratory: Evaluation of road aggregates for various properties: Sieve Analysis, Los Angeles Test, Flakiness and Elongation Test, Impact Test, Angularity Number Test, Evaluation of Bitumen for various properties: Softening Point Test, Penetration Test, Viscosity Test, Ductility Test, Stripping Test, Bituminous mix design – Marshal Mix Design Method, Headway studies: Free flow, Intermediate flow, High Flow; Speed-Volume studies; observed method; Signal design; Parking studies; O-D survey; Acceleration Noise; Vision testing.

#### **Texts:**

- P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall India.
- S. K. Khanna and C. E. G. Justo, Highway Engineering, Nem Chand Bros., 2002.
- N. A. Harold, Highway materials, Soil and Concrete, Prentice Hall, 2004.
- C. S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Hall India, 2001.
- R. Horonjeff and F. X. McKelvey, Planning and design of airports, McGraw-Hill, 1994.

#### **References:**

- IS Codes and IRC Codes.



- R.P. Roess, W.R. McShane, and E.S. Prassas, Traffic Engineering, Prentice Hall, 1990.
- H.P. Oza and G.H. Oza, Dock and Harbor Engineering, Chorotar, 4th edition, 1999.

***Sixth Semester:***

**CE 302 Design of Steel Structures**

**3-1-0-8**

Scope, stress-strain relation of steel, Assumptions -- Codes of practice, factor of safety –Steel making – Types of steel and their alloys – Stress strain relation of steel – Carbon content – strain hardening -- codes on steel – Types of rolled steel sections – Design for tension and compression – Design of trusses – design of beams and girders – design of columns under uniaxial and biaxial bending – Built-up sections -- Design under combined loading – Design of industrial structures.

**Texts:**

- N. Subramanian, Design of Steel Structures, Oxford University Press, 2008.
- L. S. Negi, Design of Steel Structures, Tata McGraw Hill, 1997.

**References:**

- S. A. Raz, Structural Design in Steel, New Age International Publisher, 2002.
- M. Edwin, J. Gaylord and J. E. Stallmeyer, Design of Steel Structures, McGraw-Hill, 1991.
- P. Dayaratnam, Design of Steel Structures, S. Chand & Co., 2003.
- S. M. A. Kazimi and R. S. Jindal, Design of Steel Structures, Prentice Hall of India Pvt Ltd, 1988.

**CE 304 Infrastructure Planning, Management and Evaluation**

**3-0-0-6**

Systems analysis of infrastructure programs and projects including the technical, social, environmental and economic aspects, Organizational aspects of infrastructure management, infrastructure project feasibility and appraisal, project finance, cost-benefit analysis, project procurement, life cycle costing and value engineering, and risk management, Business case studies, Technical feasibility studies for civil infrastructures.

**Texts/References:**

- J. Parkin and D. Sharma, Infrastructure Planning, Thomas Telford, 1999.
- R.J. Burdge and F. Vanclay, The Concepts, Process and Methods of Social Impact Assessment, Social Ecology Press, 2004.
- L. Squire and H.G. Van der Tak, Economic Analysis of Projects, John Hopkins University Press, 1975.
- A. Gilpin, Environmental Impact, Cambridge University Press, 1995.
- G.A. Shunk, Transportation Planning Handbook, Prentice Hall, 1992.
- R. Burke, Project Management – Planning and Control, Wiley, 1999.
- J. Antill and B. Farmer, Engineering Management, McGraw-Hill, 1991.

**CE 306 Town and Regional Planning**

**3-0-0-6**

Definitions of town planning and urban design, levels of planning and steps for preparation of a town plan, survey techniques in planning and urban design, concepts, functions, components and preparation of a development plan. Planning concepts related to garden city, satellite towns and ribbon development. Introduction to analytical techniques in Town Planning and Urban Design. Concepts in Regional and Metropolitan planning, land subdivision regulations and zoning, Urban Design principles and criteria, Urban Scale and Spaces. Design for the Pedestrians. Waterfront Development. Principles of Urban Conservation. Principles of Streetscape Design. Urban design regulations and control, the comprehensive role of urban design in town planning process.

**Texts/References:**

- Peter Hall and M.Tewdwr-Jones, Urban and regional planning, Routledge, Fifth Edition, 2010
- Peter Hall, Urban and regional planning, Routledge, 4<sup>th</sup> Edition, 2002
- K. V. Sundaram, Urban and regional planning in India, Vikas Pub. House, Fifth Edition, 1977

**CE 308 Machineries in Infrastructure Engineering**

**3-0-0-6**

Engineering Fundamentals of Moving Earth - Rolling resistance, Effect of grade on tractive effort, Effect of altitude on performance of IC engines; Earthmoving, Excavating, and Lifting Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks, Excavators, Backhoes, Front shovels, Cranes, and Forklifts; Piles and Pile-Driving Equipment; Production of Crushed-stone Aggregate; Concreting Equipment; Asphalt Mix Production and Placement - Asphalt Plants, and Paving Equipment; Estimating and Optimizing Construction Equipment System Productivity - Peurifoy's method of optimizing productivity, Phelps' Method, Optimizing hauling system based on loading facility; Estimation of Equipment Productivity - Mathematical models, Simulations; Scheduling Equipment-Intensive Horizontal Construction Projects - Linear scheduling method, Precedence diagramming method, Developing equipment resource packages; Scheduling Lifting Equipment for Vertical Construction; Equipment Financing Decision - Financing methods, Rental and lease contract considerations.

**Texts:**

- D. G. Gransberg, C. M. Popescu and R. C. Ryan, *Construction equipment management for engineers, estimators, and owners*, Taylor & Francis, New York, 2006.
- R. L. Peurifoy, C. J. Schexnayder, A. Shapira and R. Schmitt, *Construction planning, equipment, and methods*, 8<sup>th</sup> ed., McGraw Hill, New York, 2010.

**References:**

- D. A. Day and N. B. H. Benjamin, *Construction equipment guide*, 2<sup>nd</sup> ed., Wiley, New Jersey, 1991.
- F. Harris, *Modern construction and ground engineering equipment and methods*, 2<sup>nd</sup> ed., Longman, London, 1994.
- J. Singh, *Heavy construction - planning, equipment and methods*, 3<sup>rd</sup> ed., CRC Press, 2009.

**CE 310 Environmental Quality and Pollution Measurement Laboratory 0-0-3-3**

Analytical methods of commonly encountered Water and Air Quality Parameters: pH, Alkalinity, Electrical conductivity, Taste, Odor, Colour, Solids, Turbidity, Hardness, Chemical oxygen demand (COD), Dissolved oxygen (DO), Biochemical oxygen demand (BOD), Ions like chloride, fluoride, sulphate, Nutrients i.e. nitrogen and phosphorous, Plate counts and Most probable number (MPN), Particulate matters (PM10, PM2.5), SO<sub>x</sub>, NO<sub>x</sub>; Settling column analysis; Optimum coagulant dose; Chlorine dose and residual chlorine; Advance instrumentations.

**Texts/References:**

- C. N. Sawyer, P. L. McCarty and G. F. Parkin, *Chemistry for Environmental Engineers*, McGraw-Hill, 1994.
- APHA, *Standard Methods Examination of Water and Wastewater*, American Public Health Association, Washington DC, 1995.

**CE 314 Earthquake Resistant Design of Structures****3-0-0-6**

Analytical model: Mathematical model of Spring-mass system on moving support; Random support motion; Stochastic processes; Geological strata; Wave propagation through layered media, dilatation and shear waves, reflection, refraction and transmission; Measurement and scales, micro-zonation; FEM and numerical Analyses; non-linear effects, damage; Earthquake resistant ductile design; Repair and retrofitting.

**Texts / References:**

- S. K. Duggal, "Earthquake Resistant Design of Structures", Oxford University Press, 2007
- M. Shrikhande and Pankaj Agarwal, "Earthquake Resistant Design of Structures", Prentice hall India, 2006
- S.L. Kramer, *Geotechnical Earthquake Engineering*, Prentice Hall, 1996.

**CE 316 Advanced Soil Mechanics and Foundation Engineering****3-0-0-6**

Soil Exploration (Characterization of ground, site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and dynamic tests, insitu permeability and groundwater level), and Ground Improvement techniques (Soil stabilization and ground improvement techniques, methods for difficult or problematic ground conditions - soft soils, loose sands, seismic conditions, expansive or collapsible soils, etc., preloading, vertical drains, stone columns, heavy tamping, grouting), Stability of Slopes, Earth Pressure & Retaining Walls, Soil behavior under dynamic loads, & Geotechnical earthquake engineering, Contamination, Landfills, & Geotechnical reuse of waste material, Shallow Foundation Analysis & Design (Determination of bearing capacity from field and laboratory tests, footings subjected to eccentric-inclined loads, footings on layered soils and slopes, contact pressure distributions, proportioning of shallow foundations - isolated, combined, circular, annular, raft,), Deep Foundation Analysis & Design (piles, pile groups, under-reamed piles, pre-cast, driven cast in situ and bored piles, shaft and base resistances, down drag, pile load tests, settlement of piles, pile group, various methods for laterally loaded pile analysis, Pier and well foundations).

**Texts:**

- V. N. S. Murthy, *Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering*, CRC Press, Taylor & Francis Group, First Indian Reprint, 2010.

**References:**

- Gopal Ranjan, and A. S. R. Rao, *Basic and Applied Soil Mechanics*, New Age International Publishers, 2<sup>nd</sup> Edition 2000.
- R. F. Craig, *Craig's Soil Mechanics*, Taylor & Francis Group, 7th Edition, 2004.
- K. Terzaghi, R. B. Peck and G. Mesri, *Soil Mechanics in Engineering Practice*, John Wiley & Sons, 1996.

**CE 318 Solid Waste Management****3-0-0-6**

Solid wastes: Sources, nature and characteristics, Quantities and qualities, Rates of generation and factors affecting them, Potential of diseases, nuisances and other problems due to solid wastes, Changing nature of solid wastes and its impact on solid waste management, Environmental legislations; Solid wastes management: Generation, on-site storage, collection, separation, processing and disposal; On-site storage methods: containers, their type, size and location; Collection systems: Vehicles, routing, route balancing and transfer stations, Processing methods, recovery and reuse of materials and energy, Disposal methods such as sanitary landfill, biological digestion, composting, vermicomposting etc. Industrial and hazardous solid waste management, Urban solid waste management.

**Texts/References:**

- P. A. Vesilind, W. A. Worrel and D. R. Reinhart, Solid Waste Engineering, Thomson Brooks/Cole, First Edition, 2002.
- H. S. Peavy, D. R. Rowe and G. Tchobanoglous, Environmental Engineering, McGraw-Hill International Ed, 1985.
- M. L. Davis and D. A. Cornwell, Introduction to Environmental Engineering, McGraw-Hill, Inc, International Edition, 1991.
- A.P. Sincero and G. A. Sincero, Environmental Engineering – A Design Approach, Prentice-Hall India, 1996.

**CE 320 Traffic Engineering****3-0-0-6**

Traffic flow fundamentals; Uninterrupted Traffic flow: Traffic stream characteristics, Traffic flow models, capacity and LOS analysis; Interrupted Traffic flow: Traffic flow at signalized and non-signalized intersections; Design of Traffic facilities: Highways, intersection, interchanges.

**Texts:**

- C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Hall India, 2001.
- R. Horonjeff and F.X. McKelvey, Planning and design of airports, McGraw-Hill, 1994.

**References:**

- P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall India,
- R.P. Roess, W.R. McShane, and E.S. Prassas, Traffic Engineering, Prentice Hall, 1990.

**CE 322 Hydrology****3-0-0-6**

Precipitation, Infiltration and Evapotranspiration: Forms of precipitation, measurement, depth-duration and intensity- duration frequency relations, Evaporation – process, measurement, and estimation, Infiltration process, measurement, and estimation. Evapotranspiration measurement and estimation; Runoff and Hydrographs: Rainfall Runoff correlations, Flow duration curve. Mass curve, Droughts and floods, Factors affecting flow hydrograph, Unit hydrograph, its analysis and S-curve hydrograph, Synthetic and instantaneous unit hydrographs; Statistical analysis: Hydrologic Routing, Risk, reliability, and safety factor, Flood frequency studies; Flood forecasting: Rational method Time Area curves, Designing flood channel and flood routing; Groundwater hydrology: Flow equations Confined and unconfined flow, Well hydraulics, Steady and unsteady flow, Well losses, Specific capacity;

**Texts:**

- V.T. Chow, D.R. Maidment, and L.W. Mays, Applied Hydrology, McGraw Hill, 1998.
- V.P. Singh, Elementary Hydrology, Prentice Hall, 1993.

**References:**

- H.M. Raghunath, Hydrology – Principles, Analysis and Design, Wiley Eastern Ltd., 1986.
- D.K. Todd, Groundwater Hydrology, John Wiley & Sons, 1993.

**HS 311 Diasporic Literature****3-0-0-6**

This course will deal with one of the most popular tools of contemporary theory- the notion of diaspora and its presence in literature: Diaspora, exile, migration, old and new diaspora, identity formation, cultural assimilation, notion of home and homelessness, ideology of home and nation, homesickness, memory, nostalgia, politics of multiculturalism, the heterogeneity of diasporic groups, especially by gender, class, sexuality, caste, religion, the role of language and other cultural practices in migratory experiences; the significance of memory for the production of "imaginary homelands", Films and Indian diaspora.

**Texts:**

- Amitava Kumar, Please prove Your Identity and The Long Distance Nationalists in Husband of a Fanatic, India: Penguin Books, 2004.
- Bharti Mukherjee, Jasmine, New York: Grove Press, 1989.

- Derek Walcott, *A Far Cry from Africa and Midsummer*, Collected Poems 1948-1984. New York, Farrar, Straus, Giroux, 1986.
- Jhumpa Lahiri, *Unaccustomed Earth*, India: Random House, 2008.
- V S Naipaul, *A House for Mr Biswas*, André Deutsch, 1961.
- Sujata Bhatt, *A Different History and Search for my Tongue*, Brunizem, Carcanet Press, 2008

#### References:

- Janmejy Kumar Tiwari, *From Routes to Roots: diaspora in the novels of Salman Rushdie*, *The Criterion: An International Journal in English*, Vol.2 No. 2, June 2011.
- John McLeod, *Diaspora Identities, Beginning Postcolonialism*, Viva Books 2010.
- Manjit Inder Singh (ed.) *Contemporary Diasporic Literature: Writing History, Culture, Self*, New delhi: Pencraft International, 2007.
- Satendra Nandan, *The Diasporic Consciousness: From Biswas to Biswasghat in Harish trivedi and M. Mukherjee (ed.) Interrogating Post-colonialism: Theory, Text and context*, IAS, Shimla, 1996.
- Vijay Mishra, *Diasporic Imaginary: Theorizing the Indian Diaspora from Textual Practice* 10 (3), 1996, 421-447.

#### HS 331 Sociology of Development

3-0-0-6

**Introduction:** Scientific Study of Social Life, Concept and Context of Development, Comparative Perspectives, Systems of Governance, Role of the State, Public- Rights and Responsibilities, Indian Society- Structure and Change.

**Theories of Development:** Classical, Modernization, World System, Dependency, Structure-Agency Integration, Colonial, and Third-World Perspectives.

**Themes and Perspectives:** Rural Development, Gender and Development, Public Health, Sustainable Development, Action Research, (Mal)development- Anomie, Alienation, and Fragmented Identities, Urban Migration, Social Movements, Humanizing Development through Right-Based Approach (Right to Education, Information, Food, etc.).

#### Text/References:

- Gupta, D. (2010) *The Caged Phoenix: Can India Fly?* Palo Alto: Stanford University Press.
- Oommen, T.K. (2004) *Development Discourse: Issues and Concerns* New Delhi: Regency.
- Sen, A. (1999) *Development as Freedom* New York: Oxford.
- Shiva, V. (1988) *Staying Alive: Women, Ecology and Survival in India* London: Zed Press.
- Webster, A. (1984) *Introduction to the Sociology of Development* London: Macmillan.

#### 4<sup>th</sup> Year:

#### Seventh Semester:

#### CE 400 Summer Internship

0-0-0-2

Training for a minimum period of 8 weeks in a reputed industry / R&D lab / academic institution except IIT Patna. The student is expected to submit a report and present a seminar after the training.

#### CE 401 Infrastructure Laws and Professional Ethics

3-0-0-6

Aristotle on Ethics, Categories of ethics, Industrial development and ecological balance; rural and urban society; limit to growth; future shock; Municipal and panchayet laws; codes on building, roads, air traffic, railways, Energy and electricity, water quality and utilization, sharing of resources, environmental legislations, ISO, professional ethics: Honesty, Integrity, Transparency, confidentiality, Efficiency, Fair play, Objectivity, Confidentiality, Respectfulness and Obedience, Structural/infrastructural failure and litigation

#### Texts/References:

- John R. Rowan and Samuel Zinaich Jr., *Ethics for the Professions*, 1st edition, Wadsworth Publishing, 2002.
- W.B. Wendel, *Professional Responsibility: Examples & Explanations*, 2<sup>nd</sup> edition, Aspen Publishers, 2007.
- Richard D. Parsons, *The Ethics of Professional Practice*, 1<sup>st</sup> edition, Pearson, 2000.
- Various National Codes/Legislations/Standards.

#### CE 403 Infrastructure Project Economics, Valuation and Contracts

3-0-0-6

Preparation of DPR; Preparation of expression of Interest (EOI); Selection of architect along with time schedule and payment terms; Approval of plan by the owner and the local authority; Preliminary estimate as per DSR/PWD schedule; Preparation of Drawings inviting tender, NIT, specifications and BOQ, Advertisement for e-tendering along with proper dates; Actual estimate based on revised values; Working drawings, Quality control and progress schedule.

**Texts/References:**

- L. Squire and H.G. Van der Tak, *Economic Analysis of Projects*, John Hopkins University Press, 1975.
- D.S. Berrie and B.C. Paulson, *Professional Construction Management including C.M., Design Construct And General Contracting*, Third edition, McGraw Hill International edition, 1992.
- K.K. Chitkara, *Construction Project Management: Planning, Scheduling and Controlling*, Tata McGraw-Hill, 2008.
- J. Parkin and D. Sharma, *Infrastructure Planning*, Thomas Telford, 1999.
- Various National Codes/Legislations/Standards

**CE 405 Theory of Elasticity and Plasticity****3-0-0-6**

Three dimensional stress and strain analysis, stress - strain transformation, stress invariants; equilibrium and compatibility equations, boundary conditions; Two dimensional problems in Cartesian, polar and curvilinear coordinates, bending of a beam, thick cylinder under pressure, complex variable, harmonic and bi-harmonic functions; Torsion of rectangular bars including hollow sections, bending problems; Energy principles, variational methods and numerical methods. Plasticity : Basic concepts and yield criteria; Equations of plasticity, elasto-plastic analysis of torsion and bending problems, torsion of a bar of oval section (Sokoloskey s method), problems of spherical and axial symmetry, slip lines and plastic flow, strain hardening and FEM applications.

**Texts/References:**

- S. P. Timoshenko and J. N. Goodier, *Theory of Elasticity*, Tata McGraw Hill Education private limited.
- J. Chakrabarty, *Theory of Plasticity*, Elsevier.

**CE 407 Theory of Elastic Stability****3-0-0-6**

Introduction to theory of elastic stability, Fredholm's almodel's tenative and non-trivial solution, pre-buckling deformation, four basic models to explore stability; Stability of beams and columns under axial force, bending and torsion; stability of arches, stability of plates under in-plane bending and shear; Stability of cylindrical shells, Donell's equation, Koiter's theory of elastic stability; FEM analyses for stability of trusses, frames and shells, Geometric stiffness matrix; Post-buckling analyses; Elasto-plastic theory of column buckling.

Buckling under dynamic load, Mathieu-Hill equations for repeated axial loading of trusses and cylindrical panels; Lyapunov's theorems on orbital stability.

**Texts/References:**

- S. P. Timoshenko and J. Gere, *Theory of Elastic Stability*, Tata McGraw Hill Education private limited, 2010.
- G.J. Simitses and D.H. Hodges, *Fundamentals of Structural Stability*, Elsevier.
- M.L. Gambhir, *Stability Analysis and Design of Structures*, Springer, 2004.

**CE 409 Finite Element Method in Civil Engineering****3-0-0-6**

Basic concepts of engineering analysis, Methods of weighted residuals and variational formulations, Finite element discretization, Shape function, Lagrange and serendipity families, Element properties, Iso-parametric elements, Criteria for convergence, Numerical evaluation of finite element matrices (Gauss quadrature integration), Assemblage of elements, Analysis of plane stress/strain, axi-symmetric solids, Three dimensional stress analysis, Poisson's and Laplace equations, Flow though porous media, Solution technique; Finite element programming, Use of package programs.

**Texts / References:**

- T. R. Chandrapatula and A. D. Belegundu, *Introduction to finite elements in engineering*, Third Edition, Prentice Hall of India, 2001.
- P. Seshu, *Text book of finite element analysis*, Prentice Hall of India, 2003.
- J. N. Reddy, *An introduction to the finite element method*, McGraw Hill Inc. 1993.
- R. D. Cook. D. S. Malkus. M. E. Plesha, and R. J. Witt, *Concepts and application of finite element analysis*, fourth Edition, John Wiley & Sons, 2002.
- O.C. Zienkiewicz and R. L. Taylor, *The Finite element method*, Butterworth Heinemann (Vol I and Vol. II), 2000.
- C.S. Krishnamoorthy, *Finite Element Analysis, Theory and programming*, Tata McGraw Hill, 1994.
- K.J. Bathe, *Finite Element Procedures in Engg. Analysis*, Prentice Hall of India, 1996.

**CE 411 Integrated Region and Smart City****3-0-0-6**

Sustainable Construction: planning, Need to design for change, Design for minimum waste and pollution, Design to minimize energy, water and materials in construction and in use, Sustainable Engineering and Industrial Ecology:

Using methods that minimize environmental damage to provide sufficient food, water, shelter, and mobility for a growing world population, Greening Industrial Processes and Industrial Ecology, Designing products and processes so that wastes from one are used as inputs to another, Incorporating environmental and social constraints as well as economic considerations into engineering decisions, Sustainable Urban Management, Sustainable Development, Green economies, Innovation and Environmental Leadership

**Texts/References:**

- C. J. Lim, and Ed Liu, Smart cities and Eco-Warriors, Routledge, 1<sup>st</sup> ed., 2010

**CE 413 High-rise Structures**

**3-0-0-6**

Structural systems and concepts, matrix and approximate methods, interaction of frames, shear wall frames, twist of frames, analysis of coupled shear walls, effect of openings, large panel construction, foundation superstructure interaction, analysis and design, Stability of tall buildings.

**Texts/References:**

- Taranath B.S., Structural Analysis and Design of Tall Building, McGraw Hill, 1988.
- Dr. Y.P.Gupta, Editor. Proceedings National Seminar on High Rise Structures - Design and Construction practices for middle level cities Nov. 14 -16, 1995, New Age International Limited, Publishers, Madras.
- Wilf gang Schuller, High Rise Building Structures, John Wiley and Sons, 1977.
- Bryan stafford Smith, Alexcoull, Tall Building Structures , Analysis and Design, John Wiley and Sons, Inc., 1991.
- T.Y.Lin, D.Stotes Burry, Structural Concepts and system for Architects and Engineers. John Wiley, 1988.
- Lynn S.Beedle, Advances in Tall Buildings, CBS Publishers and Distributors, Delhi, 1986.

**CE 415 Intelligent Building Automation System**

**3-0-0-6**

Components of urban forms and their planning. Concepts of neighbourhood unit. Street system and layout in a neighbourhood. Functional planning of buildings, optimization of space: Spatial Synthesis graphical techniques, heuristic procedures, formulation of linear and non-linear optimization problem. Space requirements and relationships for typical buildings, like residential offices, hospitals, etc.

Standard fire, fire list, fire resistance, classification of buildings, means of escape, alarms, etc. Engineering services in a building as a systems. Lifts, escalators, cold and hot water systems, waster water systems, and electrical systems.

Building Maintenance: Scheduled and contingency maintenance planning. M.I.S. for building maintenance. Maintenance standards. Economic maintenance decisions.

**Texts/References:**

- S. Wang, Intelligent Buildings and Building Automation, Taylor & Francis, Spon Press, 1<sup>st</sup> ed., 2010.
- Albert Ting-Pat So, and W. L. Chan, Intelligent Building Systems, Springer, Kluwer Academic Publishers group, 1999.

**CE 417 Soil Exploration and Ground Improvement Techniques**

**3-0-0-6**

Planning For Subsurface Exploration, Site investigation methods, Drilling techniques, Sampling techniques, *In-situ* field testing, Types of samplers, Soil compaction methods, compaction control; Soil stabilisation [using additives, sand drains, stone columns, lime columns, Grouting (types of grouts, methods of grouting), Soil reinforcement (using strips, geogrids, geotextiles, geomembranes); Dewatering methods; Soil nailing; Underpinning]

**Text / Reference:**

Nihar R Patra, "Ground improvement Techniques", Vikas Publishing House pvt Ltd., First Edition 2012.

V. N. S. Murthy, "Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering", CRC Press, Taylor & Francis Group, First Indian Reprint, 2010.

K. Terzaghi, R. B. Peck and G. Mesri, *Soil Mechanics in Engineering Practice*, John Wiley & Sons, 1996.

**CE 419 Groundwater Hydrology**

**3-0-0-6**

Introduction to groundwater hydrology; Well and aquifer characteristics; Groundwater flow in aquifers, groundwater recharge, fluctuation of water table beneath a recharge site; Hydraulics of fully and partially penetrating wells in confined, leaky and unconfined aquifers under steady and transient conditions; Analysis of pumping test data; Groundwater investigations; Basin management of groundwater and groundwater quality; Model studies; Sea water intrusion.

**Texts/ References:**

- D.K. Todd, *Groundwater Hydrology*, John Wiley & Sons, 1993.
- C. Walton, *Groundwater Resources Evaluation*, McGraw Hill, 1970.
- H.M. Raghunath, *Groundwater Hydrology*, New Age International, 1993.

- O.D.L. Strack, *Groundwater Mechanics*, Prentice Hall, 1989.
- S.P. Garg, *Groundwater and Tube Wells*, Oxford & IBH Publishing Co., 1993.

### **CE 421 Railway Engineering**

**3-0-0-6**

Indian Railway Track - different gauges, cross sections, coning of wheels; Tractive resistances; Track components - rails, rail failures, sleepers, rail fixtures and fastenings and ballast; Geometric design of the track; Points and crossings Track junctions; Stations and yards; Signalling and interlocking; Track stresses; Track construction and maintenance.

#### **Texts/References:**

- Sexena, S.C. Arora, S. P. (1990). A text Book of Railway Engineering, Dhanpat Rai & Sons, New Delhi.
- Munday, J.S. Railway Track Engineering, Tata McGraw Hill, New Delhi.
- Agarwal, M. M. (1991). Indian Railway Track, Sachdeva Press, Mayapuri, New Delhi.
- Hay, W. W. (1988). Railroad Engineering, John Wiley and Sons, New York.

### **CE 423 Design of Water Treatment Infrastructures**

**3-0-0-6**

Design of water supply systems: water quality standards, raw water characteristics, Selection of site for the source of water supply, design of units for sedimentation, coagulation, flocculation, granular media filtration, disinfection, water softening, advanced treatments units, pumping and distribution system; Hydraulics of treatment plant: flow measurement and hydraulic control points, hydraulic analysis of unit operations, hydraulic profile through the treatment plant; Design of city water supply system.

#### **Texts/References:**

- J. M. Montgomery, *Water Treatment Principles and Design*, John Wiley & Sons, 1985
- H. S. Peavy, D. R. Rowe and G. Tchobanoglous, *Environmental Engineering*, McGraw-Hill International Ed., 1985.
- T. J. McGhee, *Water Supply and Sewerage*, McGraw-Hill, Inc, 1991.
- *Manual for Water Supply and Treatment*, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.

### **CE 425 Environmental Hydraulics**

**3-0-0-6**

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

#### **Texts/References:**

- V.P. Singh, Willi H. Hager, *Environmental Hydraulics*, Springer, 1996.
- L. Hamill, *Understanding Hydraulics*, Palgrave Macmillan; 2<sup>nd</sup> Rev. Ed., 2001.

### **CE 427 Prestressed Concrete**

**3-0-0-6**

Design of prestressed concrete sections for flexure, shear, bond and anchorage forces minimum weight design; Analysis and design of indeterminate prestressed structures, Choice of cable profiles, Concordancy and linear transformation of cable profile, effect of creep and shrinkage on prestressed concrete structures; Design of end block, Partial prestressing, Definition- principles and design approach, Composite structures; Wind load analysis on Industrial building, Braced and Unbraced Industrial building.

#### **Texts /References:**

- E. G. Nawy, *Prestressed Concrete: A fundamental approach*, Prentice Hall, 1995.
- T.Y. Lin, *Design of Prestressed Concrete Structures*, John Wiley, & Sons, 1963.
- S.K. Mallick and A.P. Gupta, *Prestressed Concret*, Oxford & IBH, 1992.
- G.S. Charles and J.E. Johnson, *Steel Structures-Design and Behaviour*, Addison –Wesley, Pub Co., 1997.
- W.F.Chen and S.Toma, *Advanced analysis of steel frames*, CRC press, 1994.

### **CE 429 Composite Structure**

**3-0-0-6**

Brief introduction of composite materials and their classifications, Macromechanics and Anisotropic Elasticity, Computational Homogenisation, Unidirectional Periodic Structures, 2D and 3D Composites with Uniaxially Distributed Inclusions, Fibre-reinforced Composites, Algebraic Equations for Homogenised Characteristics, Asymptotic Homogenisation Method (Deterministic Approach, Monte Carlo Simulation, Stochastic Perturbation), Upper and Lower Bounds for Effective Characteristics Bending, buckling and Vibration of composite laminates,

Mechanics of FRP composites in civil engineering, Failure theories, Interfacial stress, debonding and delamination in composites.

**Texts/ References:**

- R. M. Jones, *Mechanics of Composite Materials*, Taylor & Francis, 1998.
- B D. Agarwal and J. D Broutman, *Analysis and Performance of Fiber Composites*, John Willey and Sons, 1990.
- P. K. Mallik, *Fiber reinforced composites : Materials, Manufacturing and Design*, Marcel and Dekker, 1993.
- Kaw, K. Arthur, *Mechanics of Composite Materials*, CRC Press, 1997.
- P. K, Mallik, *Composite Engineering Hand Book*, Marcel and Dekker, 1997.

**CE 431 Design of Lifeline Structures**

**3-0-0-6**

**BEHAVIOUR OF LIFE-LINE STRUCTURES:**

Philosophy for design to resist earthquake, cyclone and flood, National and International codes of practice, By-Law of urban and semi-urban areas, Traditional and modern structures. Behavior of structures in past cyclones, earthquakes and wind storms, General planning and design considerations under wind storms, earthquakes and cyclones.

**DESIGN PROCEDURE:**

Investigations for bridges, types of bridges and loading standards, selection of bridge, analysis and design of bridges, pier and abutments, different types of bridge foundations,

Wind effects on buildings, towers, glass panels etc, and features in their design, Codal Provisions – design wind speed, pressure coefficients, Introduction to international codes, Design of cyclone shelters.

**Texts/References:**

- O'Brien and D. L. Keogh, "Bridge deck analysis", E&FN Spon, New York.
- N. Krishna Raju, Design of bridges, Oxford & IBH publishing Co. Ltd., New Delhi.
- Simiu E. and Scanlan R.H., Wind Effects on Structures-Fundamentals and Applications to Design, 3rd Ed., John Wiley, 1996
- Dyrbye C.D., Dyrbye C., Dyrbye C., Wind Loads on Structures, John Wiley, 1997
- Smith B.S. and Coull A., Tall Building Structures: Analysis and Design, Willey – Inderscience, 2001
- Taranath B.S., Wind and Earthquake Resistant Buildings : Structural Analysis and Design (Civil and Environmental Engineering) , CRC Press, 2004
- V. M. Moskvina, Concrete and Reinforced Concrete deterioration and Protection - Mir Publishers - Moscow 1983.

**CE 433 Soil Dynamics and Machine Foundation Design**

**3-0-0-6**

**PRINCIPLES OF DYNAMICS AND VIBRATIONS:**

Vibration of elementary systems-vibratory motion-single and Multi degree of freedom system-free and forced vibration with and without damping

**WAVES AND WAVE PROPAGATION IN SOIL MEDIA:**

Wave propagation in an elastic homogeneous isotropic medium- Raleigh, shear and compression waves

**DYNAMIC PROPERTIES OF SOILS:**

Stresses in soil element, coefficient of elastic, uniform and non-uniform compression, shear effect of vibration dissipative properties of soils, Determination of dynamic soil properties, Field tests, Laboratory tests, Model tests, Stress-strain behavior of cyclically loaded soils, Estimation of shear modulus, Modulus reduction curve, Damping ratio, Linear, equivalent-linear and non-linear models, Ranges and applications of dynamic soil tests, Cyclic plate load test, Liquefaction

**DESIGN PROCEDURES:**

Design criteria, dynamic loads, simple design procedures for foundations under reciprocating machines, machines producing impact loads, rotary type machines Types of foundations, Modes of vibrations, Vertical, sliding, torsional (yawing) and rocking (and pitching) modes of oscillations, Design guidelines as per codes

**VIBRATION ISOLATION:**

Vibration isolation technique, mechanical isolation, foundation isolation, isolation by location, isolation by barriers, active passive isolation tests.

**Texts/References:**

- S.Prakesh & V.K Puri, Foundation for machines, McGraw-Hill 1993
- Srinivasulu, P & Vaidyanathan, Hand book of Machine Foundations, McGraw-Hill, 1996
- REFERENCES
- Swamisaran, "Soil Dynamics and Machine Foundations", Galgotia Publications Pvt. Ltd, 1999
- Kramar S.L, "Geotechnical Earthquake Engineering", Prentice Hall International series, Pearson Education (Singapore) Pvt. Ltd.



- Kameswara Rao, “Dynamics Soil Tests and Applications”, Wheeler Publishing, New Delhi, 2003
- Kameswara Rao, “Vibration Analysis and Foundation Dynamics”, Wheeler Publishing, New Delhi, 1998
- IS code of Practice for Design and Construction of Machine Foundations, McGraw-Hill, 1996.
- Moore P.J., “Analysis and Design of Foundation for Vibration”, Oxford and IBH, 1995.

### **CE 435 Design of Hydraulic Structures**

**3-0-0-6**

Introduction to Dam engineering, classification of Dams, design of spillway; Basic principle of design of hydraulic structures; Cross drainage works. Concrete dams: force and stress analysis for components like piers, bridges and trash rack and their reinforcement detailing; stress analysis around galleries, shafts and reinforcement provisions; integrated stability analysis of concrete dams considering foundation rock; construction methods for concrete dams; Embankment dams: seepage analysis (finding the phreatic line) for different types of embankment dams; seepage control measures for embankment dams; construction methods for embankment dams. Spillways and energy dissipators: design of ogee spillways; calculations for chute spillway profiles; flow characteristics of shaft and syphon spillways; types of energy dissipators, their selection and dimensioning; flow characteristics of radial gates; introduction to relevant BIS codes and guidelines; Barrages: design of barrage structure and canal head regulator; construction methods for barrages; Irrigation structures: canals, cross drainage works, falls and energy dissipators.

#### **Texts/References:**

- W.P. Creager, J.D. Justin and J. Hinds, Engineering for Dams, Vol. II and III, Wiley, 1968.
- D. Quinn, Design and Construction of Ports and Marine Structures, McGraw Hill, 1973.
- C.V. Davis, Handbook of Applied Hydraulics, McGraw Hill, New York, 1993.

### **CE 437 Statistical Methods in Hydrology**

**3-0-0-6**

Introduction to probability and statistics applications in hydrology: random variables and their statistical properties, commonly used probability distributions in hydrology, Bayes theory; Statistical analysis of hydrologic data: frequency analysis, hypothesis testing, analysis of variance; Hydrologic time series analysis and forecasting: stationarity and ergodicity, fitting and forecasting using various models, Bayesian approach, prior and posterior distribution.

#### **Texts/References:**

- C.T. Haan, Statistical Methods in Hydrology, Wiley; 2nd edition, 2002.
- R.T. Clarke, Statistical Models in Hydrology, John Wiley, Chinchester, 1994.
- V. Yevjevich, Probability and Statistics in Hydrology, Water Resources Publications, Colorado, 1972.

### **CE 439 Pavement Design and Management**

**3-0-0-6**

Pavement Materials, Pavement as multilayered structure, subgrade, base and subbase, bituminous materials, individual properties, non-linear models of granular materials and bituminous mixes elastic modules and Poisson's ratio, concrete pavement, Pavement Design, AASHTO, Shell, Asphalt Institute, Japan, Austoroads methods, analytical pavement design, Indian context, overlay design, Pavement Management, Pavement evaluation, Benkelman beam and Falling Weight Deflectometer, pavement maintenance management, financial viability, Introduction to Pavement Management Systems, Functional and structural condition of pavements, Pavement network, Pavement Distress survey, Rating procedures, Present Serviceability concept, Roughness Measurement and analysis, IRI Index, Skid Resistance Measurement, Structural Evaluation of Pavements by Nondestructive testing, Back calculation Analysis, Pavement strengthening based on Deflection data, Pavement Distress Identification and equipment, Pavement Condition Prediction Models, Maintenance and rehabilitation techniques, Network and project level Management, PMS based on analytical-empirical method, Future Directions and Research needs in PMS, Highway Development and Management (HDM) for road project investments.

#### **Texts / References:**

- D. Croney and P. Croney, *The Design and Performance of Road Pavements*, 2nd Edition, McGraw-Hill, International Series in Civil Engineering, 1992.
- Ministry of Surface Transport, Government of India, *Specification for Road and Bridge Wok*, 3rd revision, Published by IRC, 1995.
- E. J. Yoder and M. W. Witzak, *Principles of Pavement Design*, 2nd Edition, John Wiley & Sons.
- M.Y. Shahin, *Pavement Management for Airports, Roads and Parking lots*, Chapman & Hall, 1994.
- R. Haas, W. R. Hudson, and J.P. Zaniewski, *Modern Pavement Management*, Krieger Publishing Company, 1984.
- W.R. Hudson, R. Haas and W. Uddin, *Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation*, McGraw Hill, 1997.
- H. Yang, *Pavement Analysis and Design*, Huang, Prentice-Hall, Inc. Englewood Cliffs, 1993.

### **CE 441 Sanitation Techniques**

**3-0-0-6**

Building water supply and drainage; Conventional water-borne sanitation: Municipal sanitary standards and regulations, Sewage disposal in isolated unsewered areas, Septic tanks, cesspools, Imhoff tanks and their effluent disposal, Sanitation of public facilities: Markets, swimming pools, schools, roads etc., Rural sanitation, Short and long term control of insects and rodents, vector and nuisance control, Ecological sanitation, Dry toilet, Zero discharge toilet.

**Texts/References:**

- J.A. Salvato, Environmental Sanitation, Wiley, 1958.
- A Sanitation Handbook, Water, Environment and Sanitation Technical Guidelines Series - No. 3, UNICEF, 1997.
- A. Rosemarin, Jennifer R. McConville, Amparo E. Flores, and Zhu Qiang, The Challenges of Urban Ecological Sanitation: Lessons from the Erdos Eco-Town Project, China, Practical Action, 2012.
- D.D. Porto and C. Steinfeld, The Composting Toilet System Book: A Practical Guide to Choosing, Planning and Maintaining Composting Toilet Systems, Ecowaters Books, 2000.

**CE 443 Air Pollution Control Techniques**

**3-0-0-6**

Air pollutants: Sources, classification and harmful effects on environment and human health, Air quality and emission standards, Air pollution legislation; Meteorology as applied to air pollution and dispersion of air pollutants; Reactions of pollutants in the atmosphere and their effects: Smoke, smog and ozone layer disturbance, Combustion processes and pollutant emission, Air sampling and pollutant measurement methods, principles and instruments, Selection of control equipments; Engineering control concepts; Process change, fuel change; Pollutant removal and disposal of pollutants; Control devices and systems, removal of dry particulate matter, liquid droplets and mist removal, gaseous pollutants and odor removal; Control of stationary and mobile sources; Economics and trends of air pollution control.

**Texts/References:**

- K. Wark and C. F. Warner, Air Pollution-Its Origin and Control, Harper & Row, New York, 1981.
- N. D. Nevers, Air Pollution Control Engineering, McGraw Hill International Ed., 1985.
- C.D. Cooper and F.C. Alley, Air Pollution Control: A Design Approach, Waveland Press, 2002.

**CE 445 Transmission Tower Design, Erection and Maintenance**

**3-0-0-6**

Generation, Transmission & Distribution Scenario of India, Safety and environmental laws dictating transmission line layout, Tension and geometry of high-tension lines, Tension in catenaries, Wind load on cables, Oscillation and flutter in transmission lines, Safety code during erection and servicing, Design of transmission tower under snapping of different lines, Safety considerations during cyclonic weather and hazard.

**Texts/References:**

- Lecture notes and handouts will be provided

**CE/EE447 Design and Layout of Electrical Distribution Systems**

**3-0-0-6**

**(A) DISTRIBUTION LINES/CABLES**

(i) Brief historical review of Distribution system, (ii) Planning, design & selection aspects of tower/poles structure, conductors, insulators and other hardwares, (iii) Conductor laying, stringing, sagging, (iv) Layout of earthwire/neutral wire, guarding repair and jointing of conductors, jumpering, binding, (v) Design and selection of underground cables, (vi) Location, construction and erection of pole-mounted sub-stations, (vii) Service lines – LV, MV, HV Consumers compliance of IE Rules, (viii) Street Lighting-Design consideration and controlling methods, (ix) O&M of Distribution & service lines, (x) Maintenance schedules & Records

**(B) DISTRIBUTION SUB-STATIONS** (i) Types, Layouts, single line diagram/equipments, (ii) Equipments-transformer, CB, fuse etc. (iii) Relays, Relaying schemes, installation, (iv) Operation & Maintenance all equipment, protective relays and auxiliaries.

**(C) DISTRIBUTION METERING & EFFICIENT ENERGY MANAGEMENT**, (i) Types & constructional details of various meters, (ii) Indian Electricity rules regarding sealing of cut outs and meters penalty for seal breaking, (iii) Detection of theft/tempering, unauthorized loads, investigation, legal aspects, (iv) Testing consumer premises and dealing with disputed, (v) IE rules regarding system voltage drops and improvements, (vi) Distribution automation, (vii) Improving the efficiency of pump sets, street lighting, (viii) Anti-theft measures and case studies, (ix) Demand side management

**Texts/References:**

- D. R. Partick, Electrical Distribution Systems, 2<sup>nd</sup> ed., The Fairmont system, 2009.
- Anthony J. Pansini, Guide To Electrical Power Distribution Systems, 6<sup>th</sup> ed., The Fairmont system, 2005.

**Open Elective – I:**

## CS 401 Foundations of Computer Science

3-0-0-6

Probabilistic arguments: Expectation, 2nd moment, large deviation bounds, balls and bins. Hashing: Isolation Lemma and Universal hashing. Linear programming and duality theorem as a proof technique, rounding, semi-definite programming, Interior point method, Simplex for solving linear programs. Yao's Min-max theorem and applications. Algebraic methods: The dimension argument, Eigen values and Eigenvectors. Coding and information theory: Introduction. Fourier analysis, discrete fourier transform and its uses. Basic algorithmic tricks. Introduction to high-dimensional geometry, volume estimation, metric embedding and Johnson Lindenstrauss. Sampling techniques and random walks.

### Texts:

- Sanjeev Arora and Boaz Barak, Computational Complexity: A Modern Approach, Cambridge University Press.

### References:

- Lecture notes and handouts will be provided

## MA 410 Graphs, Groups and Network

3-0-0-6

Preliminaries in graphs, Mappings of Graphs, Matrices associated with graphs, Degree Sequence, Walks, Cut-Edges and Cut vertices, Weighted graphs, Directed Graphs, Shortest paths. Tree, Spanning Trees, Equivalent definitions, Prims & Kruskal Algorithm, Tree, Distance between spanning tree of a connected graph, eccentricity, Centre(s) of trees and connected graph, diameter of tree and connected graph. Cut-sets, Fundamental cut set, Edge and vertex Connectivity, Separability, Mengers theorem. Paths, circuits, Eulerian and Hamiltonian Graphs, Fleury algorithm, operation on graphs, Travelling salesman Problem, k-Connected graphs. Cliques and Minors in a Graph. Detection of planarity, Dual of a planar graph and map coloring Maximal independent sets, Vertex coloring and Chromatic Number, Vizing theorem, Chromatic Partitioning, Minimal dominating set, knights tour, Chromatic Polynomial, coverings, Number of a connected graph, matching in Bipartite graphs Flows in networks, Max-Flow-Min-Cut Theorem and its applications. Groups as Groups of Symmetries of a graph, Normal Subgroups, Isomorphism Theorems, Cyclic groups, Dihedral Groups. Permutation groups, finitely presented groups.

### Texts:

- Bondy, J. A. and Murthy, U.S.R.: Graph Theory, Springer, 2008
- Deo N.: Graph Theory with Appl. to Engineering & Computer Science, PHI 1993
- West D.B.: Introduction to Graph Theory, Prentice-Hall of India, 2009
- Harary, F.: Graph Theory, Narosa, 1988

## ME 481 Introduction to Biomechanics

3-0-0-6

**Introduction to Biological System; Cell, Tissues and Connective Tissues and their Phenomenological Models: Bone, Tendon, Cartilage, Smooth Muscle cells:** Musculo-Skeletal system as a tensigrity structure, Gait Analysis: Locomotion and Control, Modeling of Humanoid Robots, Physiology and mechanical properties of muscles-Viscoelastic model of muscle, Tetanization pulse in muscle fibers, Physiology and mechanical properties of bones- Bones as bidirectional fibers-nets and its stress response; **Circulation system:** Composition and rheological properties of blood, Construction of RBC, Composition of Artery and Venus walls, Operation of heart as a pump and electrical potential; **Neural system and control:** Central nervous system, Auxiliary nervous system; **Experiment on Biological system:** experiment on RBC like system, viscosity measurement Blood-like liquid, ECG, Blood pressure, Pressure distribution of Human walk on the foot; **Growth, Remodeling and Residual Stresses:** Mathematical model of growth, Mathematical model of tumor, Remodeling of biological tissues like skin, artery- Wrinkle of skin, ageing of artery, Modeling of Residual stress, **Experiment on Biological system-** Determination of residual stress in artery-like tissue, Determination of ageing affect on arterial tissue; **Instrumentation Technique in Biomechanics:** Measurement of Biopotential – ECG, EMG, ENG, Test on Respiratory Mechanism, Ultrasonic measurement of Blood flow, Drug Delivery Systems; **Application of Biomechanics:** Sports Biomechanics, Artificial Limbs and organs, Occupational Biomechanics- consideration in Machine Control and Workplace Design, Injury Biomechanics – Analysis and optimal design; **Biomaterial.**

### Texts:

- Jay D. Humphrey and Sherry DeLange, An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, Springer; 1st Experiment Edition, 2004.
- Roger Bartlett, Introduction to Sports Biomechanics: Analysing Human Movement Patterns, Routledge; 2nd Edition, 2007.
- Stephen C. Cowin and Jay D. Humphrey, Edt. Cardiovascular Soft Tissue Mechanics, Kluwer Academic Publishers, 2000.
- Walter D. Pilkey, Dmitry V. Balandin and Nikolai N. Bolotnik, Injury Biomechanics and Control: Optimal Protection from Impact, 1st Edition. Wiley 2009.

- Don B. Chaffin, Gunnar B. J. Andersson and Bernard J. Martin, Occupational Biomechanics, Wiley-Interscience 3rd Edition, 1999.
- John G. Webster, Medical Instrumentation: Application and Design, Wiley; 3rd Edition, 1997.

#### PH 401 Introduction to Nanomaterials

3-0-0-6

**Introduction:** Overview of Nanotechnology, Quantum effect, Nanotechnology in nature.

**Properties:** Physical, Chemical and biological properties of nanomaterials, Effects on structure, ionization potential, melting point, and heat capacity Electronic structure at nanoscale, Magnetism at Nanoscale.

**Metal and Semiconductor Nanoparticles:** Surface Plasmon Resonance, Theory, Stability of metal particles, metamaterials, Nanowires and Nanotubes.

**Synthesis of Nanomaterials:** Chemical, Physical, Biological and hybrid Methods of synthesis, Assembly. Carbon Nanotubes, Lithographic methods, Scanning Probe Microscopic Methods, Physical and Chemical Vapor Deposition Methods. MEMS fabrication technique.

**Nanotribology and Nanomechanics:** Micro/Nanotribology and Materials Characterization Studies using Scanning Probe Microscopy, Surface Forces and Nanorheology of Molecularly Thin Films, Scanning Probe Studies of Nanoscale Adhesion Between Solids in the Presence of Liquids and Monolayer Films, Friction and Wear on the Atomic Scale, Nanoscale Mechanical Properties, Nanomechanical Properties of Solid Surfaces and Thin Films, Mechanics of Biological Nanotechnology, Mechanical Properties of Nanostructures, Micro/Nanotribology of MEMS/NEMS Materials and Devices.

**Applications of Nanomaterials:** Materials, Sensors and Actuators, Catalysis Medical Applications, Advanced Electronic Materials and Novel Devices. MEMS/NEMS Devices and Applications, Current Challenges and Future Trends.

#### Texts:

- Introduction to Nanotechnology; Charles P. Poole, Jr. and Frank J. Owens, Wiley – Interscience, 2003.
- Introduction to Nanoscience; Gabor L. Hornyak, Joydeep Dutta, Harry F. Tibbals, A. K. Rao, CRC Press, Taylor and Francis Group, 2008.

#### References:

- Springer Handbook of Nanotechnology; Bharat Bhushan (Ed.), Springer-Verlag, Berlin, Heidelberg, 2004.
- Fundamentals of Microfabrication: Science of Miniaturization; M.J. Madou, CRC Press, 2nd Edition, 2002.
- Nanostructures & Nanomaterials: Synthesis, Properties and Applications; Guozhong Cao, Imperial College Press, 2004.
- Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices; Rainer Wasser (Ed.); WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2003.

#### PH 402 Solid State Devices

3-0-0-6

**Semiconductor Devices:** Basic introduction, principles of device fabrication and operation—heterojunction bipolar transistors (HBTs), heterostructure field effect transistors (HFETs), modulation doped field effect transistors (MODFETs), high electron mobility transistors (HEMTs), resonant tunneling diodes (RTDs), single electron transistors (SETs), negative conductance in semiconductors, transit time devices, IMPATT, TRAPATT, THz devices, micro and mm wave devices;

**Optical Devices:** Optical absorption in a semiconductor, photoconductors, photovoltaic effect, semiconductor lasers, quantum well lasers, longwavelength detectors, Optical waveguides, waveguide fabrication techniques, losses in optical waveguides, Optical sensors, integrated optical devices,

**Ferroic Phenomena & Devices:** Electrical & optical properties of linear and non-linear dielectrics, Ferroelectrics, Pyroelectric, Piezoelectric and electro-optic devices, non-volatile memory; Magnetic memory and superconducting devices, shape memory effect, Spintronic devices,

**Energy Storage/Conversion Devices:** Portable power sources, Solar cell, Fuel cells, Secondary batteries, Supercapacitors

**Sensors & Actuators:** Elementary concepts of sensors, actuators and transducers, an introduction to Microsensors and MEMS, Evolution of Microsensors & MEMS, Microsensors & MEMS applications, Biosensors.

#### Texts:

- Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, 2nd Edition, Rainer Wasser (ed.), Wiley – VCH Publishers, 2003.
- Physics of Semiconductor Devices, S. M. Sze, John Wiley & Sons, 2nd edition, 1981.
- Microwave Devices & Circuits, Samuel Y. Liao, 3rd Edition, Pearson Education, 2003.
- Ferroelectric Devices, K. Uchino, 2nd edition, CRC Press, 2009.
- Semiconductor LASERS I: Fundamentals, E. Kapon, Academic Press (Indian edition), 2006.
- Optical Materials, John H. Simmons and Kelly S. Potter, Academic Press (Indian edition), 2006.
- Electronic Properties of Materials, Rolf E. Hummel, Springer (3rd edition)
- Energy Storage, R. A. Huggins, Springer, 2010.

**References:**

- Batteries for Electric Vehicles, R. Woods, D. A. J. Rand & R. M. Dell, Research Studies Press Pvt. Ltd., 1998.
- Fuel Cell Engines, Matthew M. Mench, John Wiley & Sons, 2008..
- Fuel Cell Technology, Nigel Sammes (ed.), 1st edition, Springer, 2006.
- Electrochemical Supercapacitors: Fundamentals & Technological Applications, B. E. Conway, Academic Press, 1998.
- Clean Energy, R. M. Dell & D. A. J. Rand, Royal Society Publications, 2004
- Hydrogen Energy: Challenges & Prospects, R. M. Dell & D. A. J. Rand, Royal Society Publications, 2008.
- Fundamentals of Photovoltaic Modules and their Applications, G. N. Tiwari, S. Dubey & Julian C. R. Hunt, RSC Energy Series, 2009.

**ME 449 Refrigeration and Air Conditioning****3-0-0-6****Refrigeration**

Basic Refrigeration Cycles: Carnot refrigeration cycle, Vapour compression cycle, multipressure pressure systems, Vapour absorption cycle, Bell-coleman cycle. Major components of vapour compression system: Refrigerant compressors, refrigerant condensers, refrigerant evaporators and expansion devices. Capacity control techniques: Hot gas by-pass scheme, Cylinder loading scheme, suction gas throttling scheme. Refrigerants: Classification and nomenclature, desirable properties of refrigeration, common refrigerants, environmental issues-Ozone depletion and global warming.

**Air-conditioning systems**

Classification of air-conditioners: (i) unitary Systems (Window type/self-contained/single-package unit and split-unit (ii) Central air conditioning system. Basic psychrometry: Sensible cooling and heating processes, humidification and dehumidification processes on psychrometric chart. Cooling load calculations: Transmission load, Occupancy load, Equipment load, Infiltration and ventilation load etc. Duct Design: Design considerations and procedures.

**Texts/References:**

- R.J. Dossat, Principles of Refrigeration, Pearson Education (Singapore) Pte. Ltd., 2008.
- W. Stoecker, Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1982.
- C.P. Arora, Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
- A. Ameen, Refrigeration and Air Conditioning, Prentice Hall of India Private Limited, New Delhi, 2006.
- American Society of Heating Refrigerating and Air Conditioning Engineers Inc, 2010 ASHRAE Handbook- Refrigeration Fundamentals.
- American Society of Heating Refrigerating and Air Conditioning Engineers Inc, 2010 ASHRAE Handbook- HVAC Applications.

**ME 461 Robotics and Robot Applications****3-0-0-6**

History of development of robots; Anatomy and structural design of robot; Robot kinematics; Dynamic analysis and forces; drives and control (hardware) for motions; Trajectory planning; Vision systems in robot; Image processing; End effectors and grippers; programming and control of robots; reliability, maintenance and safety of robotic systems; application of robots in manufacturing processes, e.g. casting, welding, painting, machining, heat treatment and nuclear power stations, etc; medical applications of robots, e.g. image guided surgical robots, radiotherapy, cancer treatment, etc; Social issues and future of robotics.

**Texts/References:**

- M.P Groover, M. Weiss, R. N. Nagel and N. G. Odrey, Industrial Robotics-Technology, programming and applications, McGraw-Hill Book and Company, 1986.
- S.K. Saha, Introduction to Robotics, Tata McGraw-Hill Publishing Company Ltd, 2008.
- S. B. Niku, Introduction to Robotics- analysis systems, applications, Pearson Education, 2001.
- Pires, Industrial Robot Programming - building application for the factories of the future, Springer, 2007.
- Peters, Image Guided Interventions – Technology and applications, Springer, 2008.

**CS 461 Artificial Intelligence****3-0-0-6**

Introduction to intelligent agents. Problem Solving: Searching, Intelligent search methods, Game Playing. Knowledge and Reasoning: Building a Knowledge Base. Inference in First Order Logic, Logical reasoning systems. Planning. Uncertain Knowledge and Reasoning, Probabilistic Reasoning Systems. Learning from Observations: Inductive Learning, Learning Decision Trees, Computational Learning Theory, Explanation Based Learning. Genetic algorithms, Artificial Neural Networks and Fuzzy Approaches. Introduction to Natural Language Processing. The course will include programming projects involving programming in Lisp, Prolog and C++.

**Texts:**

- S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003.

**References:**

- E. Rich and K. Knight, Artificial Intelligence, McGraw Hill, 1991.
- P. H. Winston and B. K. P. Horn, Lisp, 3rd Ed, Addison-Wesley, 1989
- P. Norvig, Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp, Morgan Kauffman, 1991.
- I. Bratko, Prolog Programming for Artificial Intelligence, 3rd Ed, Addison-Wesley, 2001.

**Eighth Semester:**

**CE 402 Risk and Reliability Analyses of Civil Infrastructure****3-0-0-6**

Introduction and overview: Review of basic probability, Functions of random variables. Joint probability distribution, conditional distributions, Joint Normal distribution, Random number generation – Monte Carlo simulations, Formulation of structural reliability problems: limit states, First order reliability methods, importance sampling and other variance reduction techniques, Reliability – historical development, applications, different measures of reliability; Component reliability - time to failure, Reliability-based maintenance, System reliability - representation of failure, series and parallel systems, redundancy, fault trees, Probability-based acceptance criteria: consequence of failure, concepts of risk, utility, Probability-based design. Calibration of target reliability: reliability-based design codes

**Texts / References:**

- H. S. Ang and W. H. Tang, “Probability Concepts in Engineering Planning and Design”, John Wiley, 1975.
- R. Ranganathan, “Reliability Analysis and Design of Structures”, Tata McGraw Hill, New Delhi, 1990.

**CE 404 Probabilistic Methods in Civil Engineering****3-0-0-6**

Role of probability in Civil Engineering; Random events, Random variables; functions of random variables; moments and expectations; Common probabilistic models - normal, lognormal, Poisson, extremal; estimation of parameters; goodness of fit tests; regression and correlation analyses, Introduction to structural reliability; FORM; elements of quality assurance and acceptance sampling, Probabilistic codes of practice and design methods, Mexican and European codes.

**Texts / References:**

- H. S. Ang and W. H. Tang, “Probability Concepts in Engineering Planning and Design”, John Wiley, 1975.
- J. R. Benjamin and C. A. Cornell, “Probability Statistics and Decision for Civil Engineers”, McGraw Hill, 1975.

**CE 406 Disaster Management****3-0-0-6**

Definitions, types of hazards, natural and manmade disasters, impact, causes and effects, damages, coping mechanism and relief assistance, disaster continuum, preparedness, prevention, mitigation, warning and management, vulnerability assessment, rehabilitation and reconstruction after disasters, pre disaster planning (for earthquakes, cyclones, floods, draught and famine), disaster resistant constructions, nonstructural and structural mitigation measures, guiding principles of mitigation, education and training for disasters, disaster case studies, computer use in disaster scenario development.

**Texts / References:**

- R.B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi, 2000
- H.K. Gupta (Ed) Disaster Management, Universiters Press, India, 2003
- R.K. Bhandani An overview on Natural & Manmade Disaster & their Reduction, CSIR, New Delhi
- M. C. Gupta Manuals on Natural Disaster management in India, National Centre for Disaster Management, IIPA, New Delhi, 2001

**CE 408 Theory of Plates and Shells****3-0-0-6**

Introduction to the analysis of plates and shells structure, **Bending theory of flat plates: Thin plates:** Kirchoff theory – strain-displacement relations, constitutive equations, equilibrium equations, boundary conditions, derivation of theory from principle of virtual work, **Rectangular plates**-solution by double Fourier series, **Circular plates, Thick plates:** Reissner-Mindlin-Naghadi type theories, Plates on elastic foundation, Moderate deflection analysis and buckling of plates, **Membrane theory of shells:** equilibrium equations, application to shells of revolution under axi-symmetric loads, applications to cylindrical shells under asymmetric loads, **Bending theory of**

**shells:** kinetic assumptions and strain displacement relations, cylindrical shell under axi-symmetric loads, bending of cylindrical shells

**Texts:**

- Timoshenko, S.P. and Kreiger, S.W., Theory of plates and shells, McGraw-Hill, 2nd ed., 1959.

**References:**

- Gould, P.L., Analysis of shells and plates, Springer Verlag, 1988
- Reddy, J.N., Theory and analysis of elastic plates and shells, 2nd ed., 2007
- Dayaratnam, P., Design of Reinforced Concrete structures, Oxford and IBH Publications, 1983,
- Ramawamy, G.S., Design and Construction of concrete Shell Roofs, McGraw-Hill, 1968.

**CE 410 Structural Health Monitoring and Retrofitting**

**3-0-0-6**

Introduction to Structural Health Monitoring (SHM) : Definition & requirement for SHM, Application of SHM: Introduction to capacitive methods, capacitive probe for cover concrete, SHM of a bridge, applications for external post tensioned cables, monitoring historical buildings, Non Destructive Testing of Concrete Structures: Situations and contexts where NDT is needed, classification of NDT procedures, visual inspection, half-cell electrical potential methods, Schmidt Rebound Hammer Test, resistivity measurement, electro-magnetic methods, radiographic Testing, ultrasonic testing, Infra Red thermography, ground penetrating radar, radio isotope gauges, other methods. Condition Survey & NDE of Concrete Structure: Definition and objective of Condition survey, stages of condition survey (Preliminary, Planning, Inspection and Testing stages), possible defects in concrete structures, quality control of concrete structures - Definition and need, Quality control applications in concrete structures, NDT as an option for Non-Destructive Evaluation (NDE) of Concrete structures, case studies of a few NDT procedures on concrete structures. Rehabilitation and Retrofitting of Concrete Structure: Repair rehabilitation & retrofitting of structures, damage assessment of concrete structures, Materials and methods for repairs and rehabilitation, modeling of repaired composite structure, structural analysis and design - importance of re-analysis, execution of rehabilitation strategy. Case studies

**Texts / References:**

- Daniel J. Inman, Charles R. Farrar, Vicente Lopes Junior, Valder Steffen Junior, **Damage Prognosis: For Aerospace, Civil and Mechanical Systems**, John Wiley & Sons, 2005.
- Chee-Kiong Soh, Yaowen Yang, Suresh Bhalla (Eds.), Smart Materials in Structural Health Monitoring, Control and Biomechanics, Springer, 2012.

**CE 412 Green Building System**

**3-0-0-6**

Introduction to sustainability and sustainable building, Concept of green building, TERI and GRIHA rating system, Understanding the rating system and accreditation process, Effect on the construction industry, Integrated design aspects, Site development, Green building materials and resources, Material reuse and construction waste recycling, Environmental thermodynamics primer, Integrated building energy system, Energy efficient design, Energy conservation, Indoor environmental quality, Wastewater reclamation and reuse, Economics of green building and future sustainability.

**Texts / References:**

- D. Mumovic and M. Santamouris (eds.), A Handbook of Sustainable Building Design and Engineering: An Integrated Approach to Energy, Health and Operational Performance, Earthscan, 2009.
- V. Bokalders and M. Block, The Whole Building Handbook: Healthy Buildings, Energy Efficiency, Eco-cycles and Place, Earthscan, 2009.
- GRIHA Manual, Vol. I and II, MNRE and TERI, 2010.

**CE 414 Inspection and Repair of Foundations**

**3-0-0-6**

Investigation and evaluation of damaged foundations, analysis of causes and failure mechanisms; repair techniques and remedial measures; preventative measures; optimization of repair effectiveness.

**Texts / References:**

- G. G. Marino (1997). "Earthquake damage: inspection, evaluation and repair, Lawyers & Judges Publishing Company, Inc.
- Bowles, J. E. (1997). Foundation Analysis and Design, 5<sup>th</sup> Edition, McGraw-Hill.

**CE 416 River Engineering**

**3-0-0-6**

River basins; erosion from river catchments and its transportation by rivers; classification of streams, delta, alluvial fans, point bars, etc.; hydraulic geometry and plan form of alluvial rivers; features of gravel bed rivers; bed level changes in streams; sedimentation on the upstream and degradation on the downstream of dams and barrages; morphology of some Indian rivers; river flow measurement techniques; stream gauging and analysis of rating curves

(hydrometry); dynamics of tidal rivers and estuarine flows; mathematical models for sediment transport and pollutant transport in rivers; introduction to software packages for river flow, sediment and pollutant transport; riverbank erosion mechanisms; direct bank erosion protection methods (use of fascine mattresses; geosynthetics; other options); indirect bank erosion protection methods (flow deflection using spurs, groynes, etc. and their possible ill effects); foundations for bridges across rivers; river training works (guide bunds) for bridges and barrages.

**Texts/References:**

- H.H. Chang, Fluvial processes in River Engineering, Wiley-Interscience, 1988. .
- C.R. Thorne, R.D. Hey, M.D. Newson, (eds.) Applied Fluvial Geomorphology for River Engineering and Management, John Wiley and Sons, 1997.
- M.S. Yalin, River Mechanics, Pergamon Press, 1992.
- M.S. Petersen, River Engineering, Prentice Hall, 1986.

**CE 418 Airport Systems Planning and Design**

**3-0-0-6**

Aircraft characteristics related to airport design; Airport configuration - runway configurations, relation of terminal area to runways, runway orientation; Geometric design of the airfield - ICAO and FAA design standards, runways, taxiways, holding aprons and aprons; Planning and design of the terminal area - apron-gate system, size and number of gates, aircraft parking configurations, the passenger terminal system; airport lighting and marking; air traffic control; airport planning and air travel demand forecasting; Structural design of airfield pavements.

**Texts/References:**

- Horonjeff, R. Mckelvey, F. X. (1994). Planning & Design of airports, Mc Graw Hill, New York.
- Khanna, S. K. Arora, M. G. and Jain, S. S. (1994). Airport Planning and Design, Nemchand Bros., Roorkee.
- Ashford, N. and Wright, P. H. (1979). Airport engineering, John Wiley, New York.

**CE 420 Design of Sewerage and Wastewater Treatment Infrastructures**

**3-0-0-6**

Design of sewer and sewerage systems; Design of wastewater treatment plant: Wastewater characteristics, Effluent discharge standards, Design of preliminary and primary unit operations: screening, grit removal, equalization, and sedimentation; Wastewater pumping; Design of secondary and biological unit operations: aerobic and anaerobic processes; activated sludge process and its modifications, trickling filter, oxidation ditch, oxidations ponds, aerated lagoons, UASB systems etc.; Design of sludge handling units: sludge thickening, sludge digester, sludge drying bed; Hydraulics of wastewater treatment plant: flow measurement and hydraulic control points, hydraulic analysis of unit operations, hydraulic profile through the treatment plant; Design of wastewater treatment plant; Design of sea/ocean disposal.

**Texts/References:**

- S. J Arceivala and S. R. Asolekar, *Wastewater Treatment for Pollution Control and Reuse*, Tata McGraw Hill, 2006.
- Metcalf & Eddy, *Wastewater Engineering- Treatment and Reuse* (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill, 4<sup>th</sup> Edn., 2004.
- Manual for Sewer and Sewerage, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1993.

**CE 422 Hazardous Waste Management**

**3-0-0-6**

Introduction to hazardous wastes, Definition of hazardous waste, The magnitude of the problem, Risk assessment, Environmental legislation, Characterization and site assessment, Waste minimization and resource recovery, Physico-chemical and biological treatment, Transportation of hazardous waste, Ground water contamination, Landfill disposal.

**Texts/References:**

- M. LaGrega, P. Buckingham, and J. Evans, *Hazardous Waste Management*, McGraw Hill, 2000.
- Charles A. Wentz, *Hazardous Waste Management*, McGraw-Hill, 1995.

**CE 424 Heavy Construction Methods and Machines**

**3-0-0-6**

Industrial structure, High rise buildings; Sewerage construction; Deep underground tunnels; Cable stayed bridges, Mountain roads, Offshore structures;  
Design Criteria: Safety (against live load, wind, earthquake) stability, serviceability (deflection, impact, vibration, flutter and comfort), useful life, maintenance, Safety during construction,  
Machineries: Excavators, shovels, Earth movers, compactors, trucks and dumpers; Batching plants, Concrete pumps, Cranes, Tower cranes, winches and ropeways; Lifts, escalators, vibrators; Pile rigs, rock drills, ell and caisson shuttering, Scaffolding; Pumps, Blowers, Pre-stressing jacks, guniting and pressure grouting pumps.



**Texts / References:**

- Stuart Wood, Heavy construction: equipment and methods, Prentice Hall, 1977
- J. A. Havers, F. W. Stubbs, Handbook of heavy construction, McGraw-Hill, 1971
- Frank Harris, Modern construction and ground engineering equipment and methods, Longman Scientific & Technical, 1994.

**CE 426 Structural Optimization****3-0-0-6**

1. Review of numerical optimization methods
2. Structural applications of linear and discrete methods
3. Approximation techniques: Conservative Approximation, Method of Moving Asymptotes (MMA), Two-Point Exponential Approximation (TPEA), Trust Regions, Shape Optimization, Force Approximation, Rayleigh Quotient Approximation (RQA), Discrete Variables: Branch & Bound
4. Sensitivity analysis techniques: Design of Experiments (DOE), Response Surface Methods (RSM)
5. Decomposition and multidisciplinary optimization: Genetic Algorithms, Discrete Variable Examples, Multi-Objective (Pareto) Optimization, Topology Optimization, Evolutionary Structural Optimization
6. Reliability based design optimization: Reliability Based Design Optimization (RBDO), Multilevel Optimization

**Texts / References:**

- Arora, J.S., *Introduction to Optimum Design*, Second Edition, Elsevier, 2004.
- Haftka, R.T. and Gurdal, Z., *Elements of Structural Optimization*, Third Revised Edition, Kluwer Academic Publishers, 1992.
- Keane, A. J., and Nair, P. B., *Computational Approaches for Aerospace Design*, First Edition, Wiley, 2004.
- Belegundu, A.D. and Chandrupatla, T.R., *Optimization Concepts and Applications in Engineering*, Prentice Hall, Inc., Upper Saddle River, New Jersey, 1999.

**CE 428 Soil-Structure Interaction****3-0-0-6**

General soil-structure interaction problems. Contact pressures and soil-structure interaction for shallow foundations. Concept of sub grade modulus, effects/parameters influencing subgrade modulus. Analysis of foundations of finite rigidity, Beams on elastic foundation concept, introduction to the solution of beam problems. Curved failure surfaces, their utility and analytical/graphical predictions from Mohr-Coulomb envelope and circle of stresses. Earth pressure computations by friction circle method. Earth pressure distribution on walls with limited/restrained deformations, Dubravo's analysis. Earth pressures on sheet piles, braced excavations. Design of supporting system of excavations. Arching in soils. Elastic and plastic analysis of stress distribution on yielding bases. Analysis of conduits. Design charts for practical use. Modern concept of analysis of piles and pile groups. Axially, laterally loaded piles and groups. Interaction analysis. Reese and Matlock's unneling d solution. Elastic continuum and elasto-plastic analysis of piles and pile groups. Hrennikoff's analysis. Ultimate lateral resistance of piles by various approaches. Non-linear load-deflection response. Uplift capacity of piles and anchors.

**Texts / References:**

- Selva durai, A.P.S., "Elastic analysis of soil foundation interaction".
- H. G. Poulos, and E. H. Davis, *Pile Foundation Analysis and Design*, Krieger Pub Co., 1990.
- Scott, R.F., "Foundation Analysis".
- Structure Soil Interaction- State of Art Report, Institution of Structural Engineers, 1978.
- S.L. Kramer, *Geotechnical Earthquake Engineering*, Prentice Hall, 1996.
- J. P. Wolf, "Dynamic Soil-Structure Interaction", Prentice-Hall, 1985.

**CE 430 Reinforced Earth****3-0-0-6**

Geo-synthetics (classification, functions, applications, properties & testing); Applications and advantages of reinforced soil structure; Principles, concepts and mechanism of reinforced soil; Soil-reinforcement interface friction; Behaviour of Reinforced earth walls (basis of wall design, internal and external stability condition, Codal provisions; Seismic design consideration); Bearing capacity improvement and design of foundations resting on reinforced soil; embankments on soft soils; Design of reinforced soil slopes, Indian experiences; Use of geosynthetics for separations, drainage and filtration; Use of geosynthetics in roads, airports and railways; India Road Congress, AASHTO and other relevant guidelines; randomly distributed fiber reinforced soil; Soil nailing; Geocell, PVD, Geosynthetics in Environmental Control (Liners for ponds and canals; covers and liners for landfills – material aspects and stability considerations); Use of jute, coir, natural Geotextiles, waste products such as scrap tire, LDPE and HDPE strips, as reinforcing material.

**Texts / References:**

- Koerner, R.M. "Designing with Geosynthetics", Prentice Hall, New Jersey, USA, 4th edition, 1999.

- Jewell, R.A., "Soil Reinforcement with Geotextiles", Special Publication No. 123, CIRIA, Thomas Telford. London, UK, 1996.
- Geosynthetics - New Horizons, Eds. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana, Asian Books Private Ltd., New Delhi, 2004.
- International Conference on soil reinforcement, Reinforced Earth and other Techniques, Paris, March, 1979.
- Second International Conference on Geotextiles, Lan Vegas, August, 1982.
- International Conference on In Situ Soil and Rock Reinforcement, Paris, October 1984.

### **CE 432 Introduction to Remote Sensing and GIS**

**3-0-0-6**

Remote sensing system; Physics of remote sensing, EMR characteristics and interaction in atmosphere and with ground objects; Sensor types characteristics: types of resolution, satellites and data products; Image processing, interpretation elements; Classification; Geometric and radiometric distortions, Geo-referencing, resampling methods; Atmospheric errors and removal; Satellite orbits and characteristics; Applications of optical and microwave remote sensing techniques in Civil and Infrastructure Engineering; Introduction to GIS and its applications.

#### **Texts / References:**

- T.M. Lillesand and R.W. Kiefer, *Remote Sensing and Image Interpretation*, John Wiley & Sons, New York, 1994.
- J.B. Campbell, *Introduction to Remote Sensing*, Taylor & Francis, London, 1996.
- F.F. Sabins, *Remote Sensing: Principles and Interpretation*, W.H. Freeman and Company, New York, 1997.
- R.N. Colwell (Editor-in-Chief), *Manual of Remote Sensing, Vol. I & II*, American Society of Photogrammetry, Falls Church, Virginia, 1983.
- G. Joseph, *Fundamentals of Remote Sensing*, Universities Press, New Delhi, 2003.
- J. R. Jensen, *Remote Sensing of the Environment an Earth Resource Perspective*, Pearson Education. Delhi, 2003.

### **CE 434 Offshore Infrastructures**

**3-0-0-6**

Linear theory of waves, brief description of higher order wave theories, random waves, probability theories. Morison's equation, wave forces on fixed and floating structures and fluid structure interaction. Soil exploration beneath seabed, criteria of foundation design in offshore environment, pile behaviour under cyclic lateral loading, development of p-y curves. Analysis of piles and foundations of gravity platforms, soil liquefaction under cyclic stresses.

Various types of offshore structures and evaluation of their environmental loads. Structural idealization and analysis of forces due to wind, waves and for linear static behaviour. Wave force on inclined members, analysis of joints in offshore structures, stress concentration and fatigue life prediction. Elementary aspects of dynamic analysis and response.

#### **Texts/References**

- T. Sarapkaya and M. Isaacson, *Mechanics of Wave Forces on Offshore Structures*, Van Nostrand, Reinhold Co., N.Y., 1981.
- C.A. Brebbia and S. Walker, *Dynamic analysis of Offshore Structures*, Newnes Butterworth, London, 1979.

### **CE 436 Urban Transportation Systems Planning**

**3-0-0-6**

Introduction to Urban Transportation Planning and Four Step Travel Demand Forecasting Process, Information Needs for Travel Demand Forecasting, Travel Demand Forecasting: Trip Generation, Trip Distribution, Mode Choice and Traffic Assignment, Land use/ Transportation system and Models.

#### **Texts/References**

- Prakash Rao and Sundaram, *Regional Development Planning in India*, Vikas Publishing House, 1974.
- B.G. Hutchinson, *Introduction to Urban Transportation Systems Planning*, McGraw Hill, 1974.
- Vukan R. Vuchic, *Urban Public Transportation Systems and Technology*, Prentice Hall Inc., N.J., 1981.
- G.E. Gray and L.A. Hoel, *Public Transportation Planning Operations and Management*, Prentice Hall Inc., N.J., 1979.

### **CE 438 Environmental Management in Industries**

**3-0-0-6**

Introduction to Industrial Waste: Environmental protection vis-à-vis economic development, Types of industries and industrial pollution, Types of industrial wastes - solid, liquid and gaseous wastes, Hazardous waste - definition and concept, Characteristics of industrial wastes, Effects of industrial wastes on environment and human health, Environmental standards and legislations; Pollution Prevention and Cleaner Production: Waste minimization, Source reduction – tools and techniques, Use of alternate raw materials, Process modifications, Recycle, reuse and

byproduct recovery, Opportunities and barriers to cleaner production; Waste Treatment Techniques: Equalization, Neutralization, Removal of suspended and dissolved solids, Physico-chemical techniques, Biological treatment techniques, Concept of best available technique (BAT), Concept of common effluent treatment plant (CETP), Combined treatment of municipal and industrial wastes, Concept of zero discharge, Industrial sludge management, Control of gaseous emissions; Pollution Control in Major Industries – Case Studies: Manufacturing processes and flow sheets, Sources and characteristics of wastes, Waste reduction, treatment and disposal methods - Sugar, Distillery, Dairy, Tannery, Textile, Fertilizer, Pulp and paper, Refinery, Iron and steel, Metal plating, Thermal power plants, etc.; Environmental Performance: Environmental performance indicators, Environmental audit, Environmental management plan, Introduction to ISO and ISO 14000.

#### **Text and References:**

- de Nevers, N., Air Pollution Control Engineering, 2nd Edition, McGraw-Hill, 1999.
- Eckenfelder Jr., W.W., Industrial Water Pollution Control, 3rd Edition, McGraw-Hill, 2000.
- Ghassemi, A. (ed.), Handbook of Pollution Control & Waste Minimization, 2nd Edition, Marcel Dekker, 2002.
- Metcalf & Eddy, Wastewater Engineering - Treatment and Reuse (Revised by Tchobanoglous, G., Burton, F.L. and Stensel, H.D.), 4th Edition, Tata McGrawHill, 2004.
- Wise, D.L. and Trantolo, D.J. (eds.), Process Engineering for Pollution Control and Waste Minimization, 1st Edition, Marcel Dekker, 1994.

#### **CE 440 Environmental Statistics and Experimental Design**

**3-0-0-6**

Stochastic processes in the environment: Probability concepts; Conditional probability and Bayes theorem; Environmental data Analysis: Descriptive statistics; Averaging times; Sample size determination; Sampling frequency and duration; Measurement uncertainty; Accuracy and precision; Sample and dynamic blanks; Error propagation; Linear least-squares regression; Trend analysis; Non-parametric statistics; Experiment design and hypothesis: Factorial design of experiments; Confidence intervals; Equality of means; T-test; Analysis of variance (ANOVA); F-test; Significance of factor effects and their interactions.

#### **Texts/References:**

- Vic Barnett, Environmental Statistics: Methods and Applications, Wiley, 2005.
- Wayne R. Ott, Environmental Statistics and Data Analysis, 1<sup>st</sup> edition, CRC Press, 1995.
- Douglas E. Splitstone and Michael E. Ginevan, Statistical Tools for Environmental Quality Measurement, CRC Press, 2003.

#### **CE 444 Occupational Health, Safety and Quality Management**

**3-0-0-6**

Introduction to quality; Importance of quality; Quality transition - quality control and inspection, quality assurance, total quality management; Evolution of quality management; Planning and control of quality during design of structures; Tools and techniques for quality management; Inspection of materials and machinery; Quality assurance in construction; Systems quality management; Quality standards/codes in design and construction; (ISO:9000); Total quality management (TQM) - principles, tools and techniques. Introduction to safety; Safety and health programs in construction industry; Planning for safety provisions; Analysis of construction hazards and accidents; Construction hazards and safety guidelines; Prevention techniques for construction accidents; Site management with regard to safety recommendations; Training for safety awareness and implementation; Construction safety and health manual.

#### **Texts / References:**

- B. G. Dale, *Managing quality*, 4<sup>th</sup> ed., Blackwell Publishing, Oxford, 2003.
- C. D. Reese and J. V. Eidson, *Handbook of OSHA construction safety and health*, 2<sup>nd</sup> ed., CRC Press, Boca Raton, 2006.
- F. Harris, R. McCaffer and F. Edum-Fotwe, *Modern construction management*, 6<sup>th</sup> ed., Blackwell Publishing, Oxford, 2006.
- K. Knutson, C. J. Schexnayder, C. M. Fiori and R. Mayo, *Construction management fundamentals*, 2<sup>nd</sup> ed., McGraw Hill, New York, 2008.
- S. J. Holt, *Principles of construction safety*, Blackwell Publishing, Oxford, 2008.

#### **CE 446 Computer Aided Design of Civil Infrastructures**

**3-0-0-6**

Engineering design principles, Interactive design using workstations, and software tools. Programming languages, data structures and their design, Computer graphics, introduction to GKS, Starbase Libraries. Computer aided drafting, data base management system, simulation and optimization. Applications in Civil Engineering, structural design.

#### **Texts / References:**

- Lecture notes and handouts will be provided

**CE 448 Financial Models for Infrastructure Projects****3-0-0-6**

Economic and Policy Definitions of Infrastructure, Infrastructure and Economic Development, Foreign Investment Infrastructure Financing in Developing Countries. Financial Needs of the Infrastructure Sector, Private Participation in Infrastructure Sector, Understanding Project Financing. Financing Infrastructure Projects, Sources of Infrastructure Finance, Capital Markets and Infrastructure Financing. Risk Management, Role of Bilateral and Multilateral Agencies, Mini Cases on Infrastructure Project Financing.

**Texts/References:**

- India Infrastructure Report 2001 to 2009, Oxford University Press.
- The Report of the Committee on Infrastructure Financing, 2007. Available at [http://www.pppinindia.com/pdf/deepak\\_parekh\\_report.pdf](http://www.pppinindia.com/pdf/deepak_parekh_report.pdf).
- Rakesh Mohan Committee Report on Infrastructure: (The India Infrastructure Report: Policy Imperatives for Growth and Welfare), 1997.
- Principles of Project Finance, 2002, E. R. Yescombe, Academic Press.

**CE 450 Special Topics in Infrastructure Engineering****3-0-0-6**

Types of structures: Interstate transmission towers, lined canals, tunnels and highways; Economics and financing; maintenance, demolishing and reconstruction, Laws and regulations: Environmental and fire clearances, Tendering and Contracts; selection of architect, PMC and contractors.

**Texts / References:** Lecture slides/reference materials will be provided.

**EE 751 Modeling and Simulation of Modern Power Systems****3-0-0-6**

Structure and Operation of Modern Power Systems: Introduction to generation, transmission and distribution systems, Technical and commercial aspects involved with ESI. Modeling of Power System Components: Generators, Transmission lines, Transformers, Different types of loads, Application of Graph Theory to Power Networks: Concepts of graph theory, Oriented graphs, Primitive impedance and admittance matrices, System graph for transmission network, Network representations, Network matrices, Network reduction. Load Flow Studies: Nonlinear numerical techniques, Gauss-Seidel method, Newton's method, Convergence criteria, Classification of buses, Load flow studies, Fast decoupled method, DC load flow method, Power flow studies in system design and operation. Power System Security and Contingency Analysis: Factors affecting power system security, Contingency analysis. Power System Stability: Classification, Small signal and Transient stability, Voltage stability. Introduction to FACTS Controllers: Development and application, Shunt, Series and Shunt-Series controllers.

**Texts / References:**

- J. J. Grainger and W.D. Stevenson Jr., Power System Analysis, Tata McGraw-Hill, (1994)
- D. P. Kothari and I.J. Nagrath, Modern Power System Analysis, Tata McGraw-Hill, Third Edition, (2003)
- A. J. Wood and B.F. Wollenberg, Power Generation Operation and Control, Wiley India Edition, Second Edition, (2003)
- M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw-Hill, Second Edition, (2006)

**MA 412 Matrix Computation****3-0-0-6**

**Introduction to Direct Methods:** Diagonalization, Jordan Canonical Forms, SVD and POD, Direct Method for solving linear systems and Application to BVP, Discretization of PDE's, Sparse Matrices.

**Basic iterative methods:** Iterative method for solving linear systems: Jacobi, Gauss-Seidel and SOR and their convergence, projection method: general projection method, steepest descent, MR Iteration, RNSD method.

**Krylov subspace methods:** Introduction to Krylov subspace, Arnoldi's method, GMRES method, Conjugate gradient algorithm, Lanczos Algorithm.

**Convergence & Preconditioners:** Convergence check for Krylov subspace methods, Preconditioned CG, ILU preconditioner, Approximate inverse preconditioners, Multigrid methods.

**Parallel implementation:** Architecture of parallel computers, introduction to MPI & openMP, parallel preconditioners, domain decomposition method.

**Texts:**

- Yousef Saad, *Iterative Methods for Sparse Linear Systems*, SIAM 2003.
- Ananth Grama, George Karypis, Vipin Kumar, Anshul Gupta, *Introduction to Parallel Computing*, Addison-Wesley, 2003.
- Gene H. Golub, Charles, F. Van Loan, *Matrix Computation*, John Hopkins University Press, 1996.

**References:**

- W. H. Press, Teucolsky, S. A., Vetterling, W. T., Flannery, B. P. *Numerical Recipes in C, Fortran*, Cambridge University Press, 1996.
- R. S. Varga, *Matrix iterative Analysis*, Prentice Hall 1962.
- Gilbert W. Stewart, *Introduction to matrix computation*, Academic Press 1973.
- James M. Ortega, *Introduction to Parallel and Vector Solution of linear Systems*, Plenum Press 1984.
- S. D. Conte and Carlde Boor, *Elementary Numerical Analysis*, McGraw-Hill Pub. Com Ltd 2005.
- K Atkinson, W Han, *Elementary Numerical Analysis*, Willay India Pvt. Ltd. 200.
- William F. Ames, *Numerical Methods for Partial Differential Equation*, Academic Press 1977, 3rd edition.
- L.N. Trefethen, D. Bau, *Numerical Linear Algebra*, SIAM, 1997.

### **PH 403 Photovoltaics & Fuel Cell Technology**

**3-0-0-6**

**Photovoltaics:** Global energy scenario and impending energy crisis, Basic introduction of energy storage/conversion devices, State-of-the art status of portable power sources, Solar/photovoltaic (PV) cells, PV energy generation and consumption, fundamentals of solar cell materials, Elementary concept of solar cell and its design, solar cell technologies (Si-wafer based, Thin film and concentrator solar cells), Emerging solar cell technologies (GaAs solar cell, dye-sensitized solar cell, organic solar cell, Thermo-photovoltaics), Photovoltaic system design and applications, Analysis of the cost performance ratio for the photovoltaic energy and problems in wide-spread commercialization of the technology.

**Fuel Cells:** Fuel cells and its classification; Transport mechanism in fuel cells and concept of energy conversion; Fuels and fuel processing, Fuel cell design and its characterization; Technological issues in Solid oxide fuel cells (SOFC); PEM fuel cells; Direct methanol fuel cells (DMFC), Molten carbonate fuel cell (MCFC), Power conditioning and control of fuel cell systems.

#### **Texts:**

- Energy Storage, R. A. Huggins, Springer, 2010.
- Fundamentals of Photovoltaic Modules and their Applications, G. N. Tiwari, S. Dubey & Julian C. R. Hunt, RSC Energy Series, 2009.
- Solar Photovoltaics: Fundamentals, Technologies and Applications (2<sup>nd</sup> ed.), C. S. Solanki, Prentice Hall of India, 2011.
- Solar Cell Device Physics, Stephen Fonash (2<sup>nd</sup> ed.), Academic Press, 2010.
- Fuel Cell Technology, Nigel Sammes (ed.), 1<sup>st</sup> edition, Springer, 2006
- Clean Energy, R. M. Dell & D. A. J. Rand, Royal Society Publications, 2004
- Hydrogen Energy: Challenges & Prospects, R. M. Dell & D. A. J. Rand, Royal Society Publications, 2008.
- Fuel Cell Engines, Matthew M. Mench, John Wiley & Sons, 2008.

#### **References:**

- Fuel Cell Technology Handbook, G. Hoogers (ed.), CRC Press, 2003.
- Fuel Cell Technologies: State & perspectives; N. Sammes, A. Smirnova and O. Vasylyev (eds.), Springer, 2004.
- Electrochemical Impedance in PEM Fuel Cells: Fundamentals and applications; Xiao-Zi Yuan, C. Song, H. Wang and J. Zhang; Springer-Verlag, 2010.
- Electrochemical Nanotechnology, T. Osaka, M. Dutta, Y. S. Diamand (eds.), Springer, 2010.

### **CE 442 Industrial Waste Treatment and Management**

**3-0-0-6**

**Introduction to Industrial Waste:** Types of industries and industrial pollution, Types of industrial wastes - solid, liquid and gaseous wastes, Hazardous waste - definition and concept, Characteristics of industrial wastes, Effects of industrial wastes on environment and human health, Environmental standards and legislations;

**Pollution Prevention and Cleaner Production:** Waste minimization, Source reduction, Use of alternate raw materials, Process modifications, Recycle, reuse and byproduct recovery, Opportunities and barriers to cleaner production;

**Waste Treatment Techniques:** Physico-chemical and biological treatment of wastewater, Concept of common effluent treatment plant (CETP), Concept of zero discharge, Industrial sludge management, Industrial air pollution, Control of gaseous emissions;

**Environmental Performance:** Environmental audit and performance, Environmental management plan, Introduction to ISO and ISO 14000;

**Pollution Control in Major Industries – Case Studies:** Manufacturing processes and flow sheets, Sources and characteristics of wastes, Waste treatment and disposal methods – Computer & IT industry and electronic waste (e-waste), Thermal power plants, Iron and steel, Metal plating, Fertilizer, Refinery, Tannery, Food industry, etc.

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

- de Nevers, N., Air Pollution Control Engineering, 2nd Edition, McGraw-Hill, 1999.
- Eckenfelder Jr., W.W., Industrial Water Pollution Control, 3rd Edition, McGraw-Hill, 2000.

- Ghassemi, A. (ed.), Handbook of Pollution Control & Waste Minimization, 2nd Edition, Marcel Dekker, 2002.
- Metcalf & Eddy, Wastewater Engineering - Treatment and Reuse (Revised by Tchobanoglous, G., Burton, F.L. and Stensel, H.D.), 4th Edition, Tata McGrawHill, 2004.
- Wise, D.L. and Trantolo, D.J. (eds.), Process Engineering for Pollution Control and Waste Minimization, 1st Edition, Marcel Dekker, 1994.

## **ME 446 Composite Materials and Engineering**

**3-0-0-6**

### **Module 1: Introduction and Classification of Composites**

**Introduction to Composites:** General Introduction, Historical development, Concept of Composite materials

**Classification of Composites:** Classification based on Matrix Material, Classification based on reinforcements

**Types of Reinforcements/Fibers:** Role and Selection of reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Metal fibers, Alumina fibers, Boron Fibers, etc., Mechanical properties of fibres

**Matrix Materials:** Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.,

**Advantages and Applications of Composites materials:** Comparison with Metals, Advantages and limitations of Composites, Applications of composite materials

### **Module 2: Manufacturing of Composite Materials**

Hand-layup technique, Filament winding, Autoclave forming, resin transfer molding, Pultrusion, Diffusion bonding, Hot pressing method, Low pressure carbonization etc.,

### **Module 3: Micro mechanical Analysis of Laminiae**

Rule of mixture, Prediction of elastic constants, Tsai-Halpin equation

### **Module 4: Macromechanical Analysis of Lamina**

Stress-strain relations of orthotropic lamina along principal and arbitrary material direction, Transformation of elastic constants

### **Module 5: Failure Mechanics of Composite Materials**

Micro and macro-mechanics of failure

### **Module 6: Analysis of laminated composites**

Introduction to composite laminates, Lamination code, Constitutive classical lamination theory, Classification of laminates, Hygrothermal stresses in composite laminates, Analysis of laminated beams

### **Module 7: Mechanical Testing of Composites**

Specimen preparation, tensile testing, compressive testing, shear testing, flexure testing, fracture toughness testing, characterization with stress concentrations

### **Module 8: Design of composites**

Design criteria, design allowable, material selection, selection of configuration and manufacturing process. Examples: Design of tension member, Design of joints, Design of pressure vessels, Composite design for stiffness at minimum mass, Composite design for controlled thermal response

### **Module 9: Finite Element Analysis of Composite Materials**

Isoparametric element for the analysis of laminated plate, formulation of the composite stiffener element, formulation of the composite beam element, finite element analysis of laminated composite shell, FEM of laminated plates, Numerical examples

### **Texts / References:**

- A. Kaw, *Mechanics of Composite Materials*, 2<sup>nd</sup> edition, CRC Press, 2006
- M. Mukhopadhyay, *Mechanics of Composite Materials and Structures*, Orient BlackSwan, 2004
- D. Gay and S. Hoa, *Composite Materials: Design and Applications*, 2<sup>nd</sup> edition, CRC Press, 2007
- I.M. Daniel and O.Ishai, *Engineering Mechanics of Composite Materials*, 2<sup>nd</sup> edition, Oxford University Press, USA, 2005.
- B.D. Agarwal and L.J. Broutman, *Analysis and Performance of Fiber Composites*, John Wiley and Sons, 2006.
- M. Ashby, *Material Selection in Mechanical Design*, Butterworth-Heinemann, 2010.
- R.M. Jones, *Mechanics of Composite Materials*, 2<sup>nd</sup> edition, CRC Press, 1998.
- M.W. Hyer, *Stress Analysis of Fiber Reinforced Composite Materials*, Destech Pubns Inc, 2008.
- R.F. Gibson, *Principles of Composite Material Mechanics*, 3<sup>rd</sup> edition, CRC Press, 2011.
- F.L. Matthews, G.A.O. Davies, D. Hitchings and C. Scouts, *Finite Element Modeling of Composite Materials and Structures*, Woodhead Publishing, 2000.

## **EE 483 Distributed Energy Resources**

**3-0-0-6**

General Overview of electricity demand and supply, and industry structure: Vertically integrated electricity supply industry, Restructuring, Electric energy management in restructured environment, Electricity markets. Distributed generation technologies for increased efficiency: Distributed generation technologies, Integration issues, Future network architectures with DGs, Microgrids, Economics of distributed resources.

Wind turbine generation systems: Types, Power in the wind, Impact of tower height, Rotor efficiency, Wind turbine generators, Speed control, Performance of grid connected WTG, Economics, Environmental impacts.

Solar resources and photovoltaic (PV) systems: Solar spectrum, Insolation measurement, Photovoltaic systems and its engineering aspects, Standalone and grid connected PV systems.

Other renewable energy sources: Elementary concepts of fuel cell, Biomass, Tidal energy, Microturbines and their analysis for engineering application.

Energy Storage: Lead acid batteries, Ultra capacitors, Fly wheels, Superconducting magnetic storage, Pumped hydro electric storage, Compressed air energy storage.

Demand side management: Application of smart devices, Distribution automation, Demand Optimization.

**Texts:**

- N. Jenkins, J.B. Ekanayake, G. Strbac, *Distributed Generation*, IET, Renewable Energy Series, 2010
- Gilbert M. Masters, *Renewable and Efficient Electric Power Systems*, Wiley, 2004.

**References:**

- A. Keyhani, M.N. Marwali, *Integration of Green and Renewable Energy in Electric Power Systems*; Wiley, 2010.
- F.A. Farret, M. Godoy Simoes, *Integration of Alternative Sources of Energy*; IEEE Press, 2006.
- L. Freris, D. Infield, *Renewable Energy in Power Systems*; Wiley, 2008.
- D. Pimentel, *Biofuels, Solar and Wind as Renewable Energy Systems*; Springer, 2008.
- P. A. Rizzi, *Wind and Solar Power Systems: Design, Analysis and Operation*; 2/e, Taylor & Francis, 2006.

**EE 491 Visual Surveillance Systems**

**3-0-0-6**

**Basics of Image and Video Processing:** Introduction to Image Processing methods, Image Transforms, Color spaces, An overview of Video Compression Standards: H. 261, H. 263, MPEG-1, MPEG-2, MPEG-4, MPEG-7, and MPEG-21, Video shot boundary detection, motion modeling and segmentation techniques.

**Object Detection and Classification-** Shape based object classification, motion based object classification, Silhouette-Based Method for Object Classification, Haar like feature based object detection, Viola Jones object detection framework, Multiclass classifier boosting.

**Multi-Object Tracking-** Classification of multiple interacting objects from video, Region-based Tracking, Contour-based Tracking, Feature-based Tracking, Model-based Tracking, Hybrid Tracking, Particle filter based object tracking, Mean Shift based tracking, Tracking of multiple interacting objects.

**Human Activity Recognition-** Template based activity recognition, Sequential recognition approaches using state models (Hidden Markov Models), Human Recognition Using Gait, HMM Framework for Gait Recognition, View Invariant Gait Recognition, Syntactic and Statistical approaches, Description based approaches, Human interactions, group activities, Applications and challenges.

**Camera Network Calibration** - Types of CCTV (closed circuit television) camera- PTZ (pan-tilt zoom) camera, IR (Infrared) camera, IP (Internet Protocol) camera, wireless security camera, Multiple view geometry, camera network calibration, PTZ camera calibration, camera placement, smart imagers and smart cameras

**Security and Privacy of visual surveillance-** Reliable visual data protection technique without sacrificing perceptual utility, secure authentication and privacy of visual surveillance.

Implementation of algorithms based on Open CV (or Matlab) is covered in the course.

**Texts:**

- Murat A. Tekalp, *“Digital Video Processing”*, Prentice Hall, 1995.
- Y. Ma and G. Qian (Ed.), *“Intelligent Video Surveillance: Systems and Technology”*, CRC Press, 2009.
- Q. Huihuan, X. Wu, Y. Xu, *“Intelligent Surveillance Systems”*, Springer Publication, 2011.
- H. Aghajan and A. Cavallaro (Ed.), *Multi-Camera Network: Principles and Applications”*, Elsevier, 2009.
- A senior (Ed.), *“Privacy Protection in Video Surveillance”*, Elsevier, 2009.

**References:**

- Dr. Richard Szeliski, *“Computer Vision: Algorithms and Applications”*, Springer Publication, 2010.

**HS421 Fundamentals of Cognitive Science**

**3-0-0-6**

Cognitive Science: nature, history, and major findings and applications; Philosophy of language and mind; Psycholinguistic approach to the child language and cognitive development; Linguistics and the study of language in society: language, dialects, and varieties, native speakers and language acquisition, language as a mental phenomenon vs. language as behavior; multilingualism; Artificial Intelligence: Turing Test and Chinese-Room Argument, Natural language vs. artificial language; fuzzy logic; Culture as cognitive construction, culture and society, culture and language, cognition and human evolution.

**Texts / References:**

- Wilson, Robert A., & Keil, Frank C. (eds.), *The MIT Encyclopedia of the Cognitive Sciences*, Cambridge, MA: MIT Press, 2001.
- Bechtel, William, & Graham, George (eds.), *A Companion to Cognitive Science*, Malden, MA: Blackwell, 1998.
- Cummins, Robert, & Cummins, Denise Dellarosa (eds.), *Minds, Brains, and Computers: The Foundations of Cognitive Science*, Malden, MA: Blackwell, 2000.
- Rapaport, William J., "Cognitive Science", in Anthony Ralston, Edwin D. Reilly, & David Hemmendinger (eds.), *Encyclopedia of Computer Science*, 4th edition (New York: Grove's Dictionaries): 227-233, 2000.

**HS441**

**Industrial and Organizational Psychology**

**3-0-0-6**

**Introduction:** Psychology as a science of Behaviour and Mental Processes: Nature, Scope and Subject Matter of Industrial and Organizational Psychology; Time and Motion Study, Classical Hawthorne Studies.

**Employer Selection:** Recruitment Process; Selection Process - Job and Worker Analyses, Matching Job with the Person; Selection Methods - Application Blank, Biographical Inventories, References and Recommendation Letters, Interviews.

**Psychological Testing:** Characteristics of Psychological Tests; Types of Psychological Tests; Tests of Knowledge, Skills and Abilities - Interest, Aptitude and Personality Tests; Limitations of Psychological Testing Programmes.

**Training and Learning:** Need Identification; Psychological Factors in Learning; Training Methods in the Workplace; Effective Training Programme; Career Planning and Development.

**Motivation:** Needs, Incentives and Motives; Financial and Non-financial Motives; Theories of Motivation; Management of Motivation; Organizational Commitment and Job Satisfaction.

**Leadership:** Changing Views of Leadership; Theories of Leadership; Leadership Styles; Pole of Power in Leadership; Charismatic and Effective Leaders.

**Group Behaviour:** Formal and Informal Organizations in Industry; Conflicts in Organization; Resolution of the Conflicts; Decision Making Process.

**Characteristics of the Workplace:** Working Conditions - Physical and Psychological; Accident, Safety and Health; Management of Stress; Spirituality at Work.

**Organizational Communication:** Process of Communications; Upward, Downward and Horizontal Communications; Barriers to Communication; Effective Communication.

**Texts / References:**

- Schultz, D. & Schultz, S. E., *Psychology & Work Today: An Introduction to Industrial and Organizational Psychology*, 10<sup>th</sup> Ed., New Jersey: Prentice Hall, 2009.
- Landy, F. J. & Conte, J. M., *Work in the 21<sup>st</sup> Century: An Introduction to Industrial and Organizational Psychology*, 3<sup>rd</sup> Ed., New York: Wiley- Blackwell, 2009.
- Robins, S. P. & Judge, T. A., *Organizational Behaviour*, 14<sup>th</sup> Ed., New Jersey, Prentice Hall, 2010.
- Pierce G.F, *Spirituality at Work: 10 Ways to Balance Your Life on the Job*, 1<sup>ST</sup> Ed., Illinois, Loyola Press, 2005.