INDIAN INSTITUTE OF TECHNOLOGY PATNA

Programme: Bachelor of Technology in Mechanical Engineering

Curriculum

First Semester		
Course Number	**Course Title**	**L-T-P-C**
CH101	Chemistry	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 – I	0-0-3-3
HS101	English	3-0-0-6
	Total L-T-P-C	**16-4-9-49**

Second Semester		
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
	Total L-T-P-C	**14-3-10-44**

Third Semester		
MA201	Mathematics – III	3-1-0-8
CS201	Object Oriented Programming and Data Structures	3-0-3-9
HS2xx	HSS Elective	3-0-0-6
ME 201	Solid Mechanics	2-1-0-6
ME 204	Fluid Mechanics I	2-1-0- 6
ME 205	Thermodynamics	3-1-0-8
ME 211	Machine Drawing	0-0-4-4
	Total L-T-P-C	**15-4-7-47**

Fourth Semester		
HS2xx	HSS Elective	3-0-0-6
XX2xx	Science Elective	3-0-0-6
EE280	Electrical Machines	3-0-0-6
ME202	Engineering Materials	3-0-0-6
ME 203	Advanced Solid Mechanics	2-1-0-6
ME 206	Fluid Mechanics II	2-1-0-6
EE281	Electrical Machines Laboratory	0-0-3-3
ME 210	Workshop-II	0-0-6-6
ME 212	Mechanical Engineering Laboratory I	0-0-4-4
	Total L-T-P-C	**16-2-13-49**

Fifth Semester		
ME 301	Manufacturing Technology I	3 – 1 – 0 – 8
ME 302	Mechanical Measurements	2 – 1 – 0 – 6
ME 303	Design of Machine Elements	3 – 1 – 0 – 8
ME 304	Kinematics of Machinery	2 – 1 – 0 – 6
ME 305	Heat and Mass Transfer	3 – 1 – 0 – 8
ME 310	Mechanical Engineering Laboratory- II	0 – 0 – 4 – 4
ME 321	Applied Thermodynamics I	2 – 1 – 0 – 6
	Total L-T-P-C	**15-6-4-46**

Sixth Semester		
HS3xx	HSS Elective	3-0-0-6
ME 306	Manufacturing Technology II	3 – 1 – 0 – 8
ME 307	Machine Design	3 – 0 – 2 – 8
ME 308	Dynamics of Machinery	2 – 1 – 0 – 6
ME 309	Control Systems	3 – 1 – 0 – 8
ME 311	Mechanical Engineering Laboratory III	0 – 0 – 4 – 4
ME 322	Applied Thermodynamics II	2 – 1 – 0 – 6
	Total L-T-P-C	**16–4–6–46**

Seventh Semester		
ME400	Summer Training	PP/FF 0
XX4xx	Open Elective - I	3-0-0-6
ME498	Project-I	0-0-8-8*
ME xxx	Departmental Elective – I	3-0-0-6
ME xxx	Departmental Elective - II	3-0-0-6
ME 401	Industrial Engineering and Operations Research	3-1-0-8
ME 411	Mechanical Engineering Laboratory IV	0-0-4-4
	Total L-T-P-C	**12–1–12–38**

Eighth Semester		
XX4xx	Open Elective - II	3-0-0-6
HS4xx	HSS Elective	3-0-0-6
ME499	Project – II	0-0-16-16*
ME xxx	Departmental Elective - III	3-0-0-6
ME xxx	Departmental Elective - IV	3-0-0-6
	Total L-T-P-C	**12-0-16-40**

Grand Total of L-T-P-C for all semesters:	

* The work load for the courses of XX498 and XX499 are approximately equivalent to one theory course and two theory courses respectively.

Components of the Curriculum & their Total Credits											
HSS Part Component		Basic Sciences & Mathematics Component		Engineering Sciences Component		Professional Subject Component					Total Credits
Theory	Lab	Theory	Lab	Theory	Lab	Theory	Lab	Seminar	Project	Others	
30	0	56	6	44	16				24		

Components of the Curriculum & their Total Credits				
Institutional Core	Institutional Electives	Departmental Core	Departmental Electives	Total Credits
110	42		24	

Note: The first year curriculum, MA201 & CS201 in the third semester are common to all B.Tech. programmes.

Please remember the following rules.

- The credit requirements for a B.Tech. programme will be in the range of 340 - 360 credits. To get 340 credits, one has to plan 43 credits for each semester.
- Normally, the number of credits registered for during a semester should not be less than 36 credits and should not exceed 52 credits. The L-T-P loading for a semester should not exceed 32 contact hours per week.
- No semester will normally have more than six lecture based courses and four laboratory courses.

- The curriculum of an individual department may include industrial training for 8 weeks for every undergraduate student. Industrial training and/or fieldwork are to be satisfactorily completed before a student is declared eligible for the degree. The curriculum for an individual department may show a credit allocation for industrial training, if considered necessary. Normally industrial training will be arranged during the summer vacation following the sixth semester of studies.

First Semester

ME111 Engineering Drawing

ME111	Engineering Drawing	2-0-3-7	Pre-requisites: nil

Lettering and Dimensioning: Introduction to various terms; instruments IS 9609 provisions, lettering practice, vertical and inclined lettering and numerals of type A and type B. Elements of dimensioning and systems of dimensioning; shape identification dimensioning. Geometric Constructions and Engineering Curves: Division of lines, curves, angles and other simple construction elements. Conic sections -parabola, ellipse and hyperbola. Spiral, involute and helix. Cycloidal curves. Orthographic projections: First and Third Angle Projections; Projection of straight lines; lines inclined to both HP and VP. Auxiliary Planes: Auxiliary inclined and vertical planes, shortest distance between two lines. Projection of Plane Surfaces: Projections of planes in simple and complex positions. Projection of Solids: Classification of solid. Projections in simple and complex positions of the axis of the solid. Combination of solids. Sections of Solids: Sectional views and true shape of the section. Intersection of Surfaces: Edge view and section plane method. Intersections of plane edge and round surface solids. Development of Surfaces: Methods of developments, development of various solids, transition pieces, spheres. Isometric Projection: Axonometric Projections, Isometric projections of simple and combination of solids. Oblique Projections: Cabinet and Cavalier projections. Perspective Projection: Orthographic representation of a perspective setup, vanishing point and visual ray method. Three point perspective. Computer Aided Drawing: Essential features of computer aided drafting. Introduction to AutoCAD. Drawing solids and their projections from previous exercises in AutoCAD.

Texts:

- K. R. Gopalakrishna, Engineering Drawings, Subhas Stores, Bangalore, 2001.

References:

- N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar book stall, Anand, 2001.
- N. Sidheswar, P. Kanniah and V. V. S. Sastry, Machine Drawing, Tata-McGraw Hill, New Delhi, 1980.
- T. E. French, C. J. Vireck and R. J. Foster, Graphic Science and Design, 4th Ed, McGraw Hill, New York, 1984.
- W. J. Luzadder and J. M. Duff, Fundamentals of Engineering Drawing, Prentice-Hall India, New Delhi, 1995
- K. Venugopal, Engineering Drawing and Graphics, 2nd Ed, New Age International, 1994.

ME110 Workshop - I

ME110	Workshop - I	0-0-3-3	Pre-requisites: nil

Introduction to wood working, hand tools and machines; Introduction to fitting shop tools, equipment and operations; Introduction to sheet metal work; Introduction to pattern making; Introduction to molding and foundry practice; Simple exercises in wood working, pattern making, fitting, sheet metal work and molding.

Texts:

- Hajra choudhury, Elements of Workshop Technology, Vol I, Asia Publishing House, 1986.
- H Gerling, All About Machine Tools, New Age International, 1995.
- W A J Chapman, Workshop Technology, Oxford IBH, 1975.

Second Semester

ME101 Engineering Mechanics

ME101	Engineering Mechanics	3-1-0-8	Pre-requisites: nil

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

Third Semester

ME201 Solid Mechanics

ME201	Solid Mechanics	2-1-0-6	Pre-requisites: nil

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, invertiblity 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-defection 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.

Text and Reference Books:

- 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.

ME204 Fluid Mechanics I

ME204	Fluid Mechanics I	2-1-0-6	Pre-requisites: nil

Introduction to fluids: Definition of fluid, Difference between solid and fluid, Application of fluid dynamics

Properties of fluids: Intensive and Extensive properties, Continuum, density, specific gravity, specific heat, viscosity, surface tension etc.

Fluid statics: pressure, manometer, hydrostatic forces on submerged on plane surfaces, stability of immersed and floating bodies, fluids in rigid body motion etc.

Fluid kinematics: Lagrangian and Eulerian description of fluid flow, Velocity and Acceleration Fields, Fundamentals of flow visualization, streamlines, stream tubes, pathlines, streaklines and timelines, deformation of fluid elements, vorticity and rotationality.

Inviscid incompressible flows: Stream function, velocity potential for 2D, irrotational, incompressible flows;

Dimensional analysis and similitude: Nature of dimensional analysis, Buckingham-pi theorem, significant dimensionless groups in fluid mechanics, flow similarity and model studies.

Integral relations for a control volume: Reynolds transport theorem, conservation equations for mass, momentum and energy;

Differential relations for a fluid particle: conservation equations for mass momentum and energy in differential form

External incompressible viscous flow: boundary layer concept, fluid flow about immersed bodies.

Internal Incompressible viscous flow: Fully developed laminar flow in a pipe, major and minor losses in a pipe flow etc., flow measurement-constriction meters, rotameters, anemometer etc.

Text and Reference Books:

- F. M. White, 1999, Fluid Mechanics, 4th Ed, McGraw-Hill.
- B. R. Munson, D. F. Young and T. H. Okhiishi, Fundamentals of Fluid Mechanics, 4th Ed, John Wiley, 2002.
- R. W. Fox and A. T. McDonald, 1998, Introduction to Fluid Mechanics, 5th Ed, John Wiley.
- S. W. Yuan, 1988, Foundations of Fluid Mechanics, Prentice Hall of India.
- Pijush Kundu, 2002, Fluid Mechanics, 2nd Ed., Academic Press.
- Irwing Shames, Mechanics of Fluids, 4th Ed., McGraw Hill.
- Batchelor G.K., 2000, An Introduction to Fluid Dynamics,2nd edition, Cambridge University press,
- V. Streeter and Benjamin, 2001, Fluid Mechanics:First SI-Metric Edition, Tata Mc Graw Hill.
- Cengel and Cimbala, Fluid Mechanics: Fundamentals and Applications, Mc Graw Hill.
- James Fay, Introduction to Fluid Mechanics, Prentice hall India.

ME205 Thermodynamics

ME205	Thermodynamics	3-1-0-8	Pre-requisites: nil

Thermodynamic Systems, properties & state, process & cycle

Heat & Work: Definition of work and its identification, work done at the moving boundary, Zeroth law,

Properties of pure substance: Phase equilibrium, independent properties, and equations of state, compressibility factor, Tables of thermodynamic properties & their use, Mollier Diagram

First law: First law for control mass & control volume for a cycle as well as for a change of state, internal energy & enthalpy, Specific heats; internal energy, enthalpy & specific heat of ideal gases. SS process, Transient processes.

Second Law of Thermodynamics: Reversible process; heat engine, heat pump, refrigerator; Kelvin-Planck & Clausius statements ,Carnot cycle for pure substance & ideal gas, Concept of entropy; the Need of entropy definition of entropy; entropy of a pure substance; entropy change of a reversible & irreversible processes; principle of increase of entropy, thermodynamic property relation, corollaries of second law, Second law for control volume; SS & Transient processes; Reversible SSSF process; principle of increase of entropy, Understanding efficiency.

Irreversibility and availability: Available energy, reversible work & irreversibility for control mass and control volume processes; second law efficiency.

Thermodynamic relations: Clapeyron equation, Maxwell relations, Thermodynamic relation for enthalpy, internal energy, and entropy, expansively and compressibility factor, equation of state, generalized chart for enthalpy.

Thermodynamic Cycles: Otto,Diesel, Duel and Joul

Third Law of Thermodynamics

Text book (TB)/ Reference books (RB):

- Sonntag R.E., Claus B. & Van Wylen G., "Fundamentals of Thermodynamics", John Wiley & Sons, 2000, 6th ed.
- GFC Rogers and Y R Mayhew, Engineering Thermodynamics Work and Heat Transfer 4e, Pearson 2003
- J P Howell and P O Bulkins, Fundamentals of Engineering Thermodynamics, McGraw Hill,1987
- Y A Cengal and M A Boles, Thermodynamics, An Engineering Approach, 4e Tata McGraw Hill, 2003.
- Michael J. Moran & Howard N. Shapiro, Fundaments of Engineering Thermodynamics, John Wiley & Sons, 2004, 4th ed.

ME211 Machine Drawing

ME211	Machine Drawing	0-0-4-4	Pre-requisites: nil

Conventional representation of Machine Components: screw threads, spring, gears, bearings, splined shaft,

Assembly and Part Drawings: couplings, clutches, bearings, gear assemblies, I.C. Engine components, valves, machine tools, etc.;

Limits, tolerances and Fits, Surface finish: Fundamental deviations for holes and shafts. Types of fits, IS/ISO codes for limit and tolerances,

Symbols: Symbols for surface roughness, Weldments, process flow, electrical and instrumentation units

Solid Modeling: Introduction to solid modelers, solid modeling of various machine parts,

Project: A drawing project.

Text:

- Ajeet Singh, Machine drawing Includes AutoCAD, Tata Mc GrawHill, 2008.
- ND Junnarkar, Machine Drawing, Pearson Education, 2007.
- N. D. Bhatt, Machine Drawing, Charotar Book Stall, Anand, 1996.
- N. Sidheswar, P. Kanniah and V. V. S. Sastry, Machine Drawing, Tata McGraw Hill, 1983.
- SP 46: 1988 Engineering Drawing Practice for School & Colleges. Bureau of Indian Standards

Third Semester HSS Electives

HS201 INTRODUCTORY MICROECONOMICS

HS201	**INTRODUCTORY MICROECONOMICS**	**(3-0-0-6)**	**NILL**

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 Chrystals, Oxford, 2007.
- Microeconomics: An Integrated Approach, David Besanko and Ronald R. Braeutigam ,John Wiley and Sons, 2002

HS221 FUNDAMENTALS OF LINGUISTICS SCIENCE

HS221	**FUNDAMENTALS OF LINGUISTICS SCIENCE**	**(3-0-0-6)**	**NILL**

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 2: 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

HS231 INTRODUCTORY SOCIOLOGY

HS231	**INTRODUCTORY SOCIOLOGY**	**(3-0-0-6)**	**NILL**

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

HS241 General Psychology

HS241	General Psychology	(3-0-0-6)	NILL

Aim of the Course
This course covers some of the biological, psychological, and individual factors which influence human thinking, beliefs, and behaviour. This knowledge will help students in understanding their own behaviours and behaviours of others. They can also apply psychological theories and principles in their workplace and practical life.
Course Contents
Introduction: Brief History of Psychology; Human Mind and Human Behaviour; Definition; Methods; Scope and Subject Matter.
Perception: Process; Determinants of Perception; Gestalt Theory; Extra-Sensory Perception; Intuitive Judgement.
Intelligence: Concept of Intelligence; Factors and Measurement of Intelligence; Successful Intelligence and Emotional Quotient (EQ).
Learning: Process of Learning, Retention and Recall; Theories of Learning; Effective Methods of Learning.
Remembering and Forgetting: Information Processing Approach; Sensory Information Stage; Short-Term and Long-Term Memory; Process of Forgetting.
Thinking: Nature of Thinking; Concept Formation; Problem Solving; Creative Thinking; Day Dreaming.
Personality: Definition; Determinants of Personality; Theories of Personality; Assessment of Personality.
Abnormality: Normal and Abnormal; Cause and Significance of Symptoms and Mental Diseases; Mental Health; Spiritual Counselling.
Books Recommended

- McConnell, J.V. Understanding Human Behaviour (6th Ed.). New York: Holt, Rinehart and Winston.
- Myers, D.G. (2010). Psychology (9th Edition). New York: Worth Publishers.
- Griggs, R.A. (2010). Psychology: A Concise Introduction. New York; Worth Publishers.
- Brown, J.F. & Mogan, C.T. (2011). The Psychodynamics of Abnormal Behaviour. New York: Literary Licensing, LLC.

Fourth Semester-Core Courses

ME202 Engineering Materials

ME202	Engineering Materials	3-0-0-6	Pre-requisites: nil

Crystal systems and lattices. Crystallography, crystals and types, miller indices for directions and planes, voids in crystals, packing density in crystals.

Crystal imperfections: point defects, line defects, surface defects. Characteristics of dislocations, generation of dislocations.

Bonds in solids and characteristics of Metallic bonding, Deformation mechanisms and Strengthening mechanisms in structural materials.

Phase diagrams: Principles and various types of phase diagrams. Iron carbon phase diagrams.

Principles of solidifications: Structural evaluation during solidification of metals and alloys. Heat treatment of steels and CCT diagrams: Pearlitic, martensitic, bianitic transformation in steel during heat treatment.

Hot working and cold working of metals: recovery, re-crystallization and grain growth. Fracture, Fatigue and creep phenomenon in metallic materials. General classifications, properties and applications of alloy steels, tool steels, stainless steels, cast irons.

Non ferrous materials like copper base alloys, aluminium base alloys, Nickel base alloys, etc.,

Miscellaneous materials viz: composites, ceramics, etc.

Text and Reference:

- William D. Callister, Material science and Engineering and Introduction, Wiley, 2006.
- V. Raghavan, Materials Science and Engineering, Fifth Edition, Prentice Hall Of India, 2008.
- G. E. Dieter, Mechanical Metallurgy, McGraw Hill, 1988.
- W. F. Smith, Materials Science and Engineering (SIE), Tata-McGraw Hill, 2008.
- AVNER, Introduction to Physical Metallurgy, Tata-McGraw Hill, 2008.

ME203 Advanced Solid Mechanics

ME203	Advanced Solid Mechanics	2-1-0-6	Pre-requisites: nil

Uniqueness of solution, Plane stress and plane strain problems, Airy's stress function. 2-D problems in polar coordinates: Thin and thick walled cylinder, Rotating disks and cylinders, Plate with circular hole, Venant's semi-inverse method, Conjugate function method, Prandtl stress function, Complex function method, Polynomial and Fourier series solutions. Elliptical and triangular shaft, shaft with cutout, rectangular shaft, Membrane analogy, narrow rectangular shaft, Hydrodynamical Saint Venants principle, Torsion of non-circular bars: Saint analogy, hollow shafts, thin tubes. Curved beam, Vertical loading on straight boundary. 2-D problems in rectangular coordinates: Cantilever with end load, uniformly loaded beam. Unsymmetrical bending: pure bending of prismatic and composite beams, bending due to terminal load, determination of shear center, bars with rectangular and elliptic sections, transverse shear - 1D shear flows. Contact Stresses, Geometry of contact surface, methods of computing contact stress, deflection of bodies in point contact and line contact with normal load, Stress Concentration. Comparison of stresses and strain energies due to bending and shear. Elastic stability: Buckling of straight and bent beam-columns. Introduction to plate theory (Kirchhoff's theory).

Text and Reference:

- A. P. Boresi, R. J. Schmidt and O. M. Sidebottom, Advanced Mechanics of Materials, 6e, John Wiley, 2002.
- A. C. Ugural and S. K. Fenster, Advanced Strength and Applied Elasticity, 4e, Prentice Hall, 2003.
- S. P. Timoshenko and J. N. Goodier, Theory of Elasticity, 3e, McGraw Hill International, 1970.
- I.S. Sokolnikoff ,Mathematical Theory of Elasticity, 2e, McGraw-Hill, 1956.
- Y.C. Fung, Foundations of Solid Mechanics, Prentice-Hall, 1965.
- E. P. Popov, Engineering Mechanics of Solids, 2e, Prentice Hall, 1998.
- I. H. Shames, Introduction to Solid Mechanics, 3e, Prentice Hall, 1999.
- S. C. Crandall, N. C. Dahl, and T. J. Lardner, An Introduction to the Mechanics of Solids, 2e, McGraw Hill, 1999.
- S. P. Timoshenko, Strength of Materials, vols. 1 & 2, CBS publ., 1986.

ME206 Fluid Mechanics II

ME206	Fluid Mechanics II	2-1-0-6	Pre-requisites: nil

Review: Viscous flow and boundary layer theory, flow separation, turbulence.

Compressible flow: The speed of sound; Adiabatic and isentropic steady flow - Mach-number relations, Isentropic flow with area changes; Normal-shock wave - Rankine-Hugoniot relations; Mach waves, oblique shock wave, Prandtl Meyer expansion waves; Performance of nozzles; Fanno and Rayleigh flow.

Fluid Machinery: Euler-equation for turbo-machines; Turbines: Impulse turbine- Pelton wheel; Reaction

turbine- Francis turbine, propeller turbine; Pumps: Centrifugal pump; Cavitation; Net positive suction head (NPSH); Role of dimensional analysis and similitude; Performance parameters and characteristics of pumps and turbines; Positive displacement pumps.

Text book / Reference :

- Frank M. White, 1999, Fluid Mechanics, 4e, McGraw-Hill.
- John D. Anderson, Jr., 1990, Modern Compressible Flow, 2e, McGraw-Hill.
- B.R. Munson, D.F. Young, T.H. Okiishi, 2002, Fundamentals of Fluid Mechanics, 4e, John Wiley.
- R.W. Fox and A.T. McDonald, 1998, Introduction to Fluid Mechanics, 5e, John Wiley.
- J.F. Douglas, J.M. Gasiorek, and J.A. Swafield, 2003, Fluid Mechanics, 4e, Pearson Education.
- S.M. Yahya, 2003, Fundamentals of Compressible flow, 3rd Ed., New Age International Pvt Ltd
- Balachandran P., 2009, Fundamentals Of Compressible Fluid Dynamics, PHI
- Terry White, 1999, Fluid Machinery: Performance, Analysis, And Design, CRC Press.
- B.C.S. Rao, 2008, Fluid Mechanics and Machinery, TMH
- Round G.F., 2004, Incompressible Flow Turbomachines: Design, Selection, Applications, and Theory, Butterworth-Heinemann

ME210 Workshop - II

ME210	Workshop - II	0-0-6-6	Pre-requisites: nil

Introduction to moulding and foundry practices

Introduction to machine tools and machining processes; types of cutting tools; selection of machining process parameters; machining operations on lathe, shaping, milling, drilling, grinding machines.

Modern manufacturing trends: CNC and CAM; Introduction to gas and arc welding processes

Text:

- Hajra Choudhury, Hajra Choudhury and Nirjhar Roy, Elements of Workshop Technology, 12th Ed, Vol. 1 & 2, Media Promoters & Publishers Pvt. Ltd. 2007.
- W. A. J. Chapman, Workshop Technology, Part I, II & III, Viva Books Private Ltd, 2004.
- P N Rao, Manufacturing Technology, 3rd Ed, Vol.1 & 2, New Age Tata McGraw-Hill, 2009.
- J P Kaushish, Manufacturing Processes, Eastern Economy Edition, Prentice Hall of India, 2008.
- M P Grover, Automation, Production system and Computer Integrated Manufacturing, 2nd Edition, Prentice Hall of India, 2008.

ME212 Mechanical Engineering Laboratory - I

ME212	Mechanical Engineering Laboratory - I	0-0-4-4	Pre-requisites: Nil

Strength of materials: Tensile testing of steel, hardness, torsion, and impact testing;

Fluid Mechanics and hydraulics: Flow through restrictive passages like orifice, venturi, weirs and notches, head losses in piping systems.

Data acquisition: Using data acquisition systems, programming a virtual instrument using standard interfaces.
Fourth Semester-Science Electives

GREEN CHEMISTRY AND TECHNOLOGY

CH201	GREEN CHEMISTRY AND TECHNOLOGY	3-0-0-6	Pre-requisites:Nil

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, fluorous biphase 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.

Texts:

- 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.

References:

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

Algebra and Number Theory

MA212	Algebra and Number Theory	3-0-0-6	Pre-requisites:Nil

Algebra: Semigroups, groups, subgroups, normal subgroups, homomorphisms, quotient groups, isomorphisms. Examples: group of integers modulo m, permutation groups, cyclic groups, dihedral groups, matrix groups. Sylow's theorems and applications. Basic properties of rings, units, ideals, homomorphisms, quotient rings, prime and maximal ideals, fields of fractions, Euclidean domains, principal ideal domains and unique factorization domains, polynomial rings. Finite field extensions and roots of polynomials, finite fields.

Number Theory: Divisibility, primes, fundamental theorem of arithmetic. Congruences, solution of congruences, Euler's Theorem, Fermat's Little Theorem, Wilson's Theorem, Chinese remainder theorem, primitive roots and power residues. Quadratic residues, quadratic reciprocity. Diophantine equations, equations $ax+by=c$, $x^2+y^2=z^2$, $x^4+y^4=z^2$ Simple continued fractions: finite, infinite and periodic, approximation to irrational numbers, Hurwitz's theorem, Pell's equation. Partition functions: Formal power series, generating functions and Euler's identity, Euler's theorem, Jacobi's theorem, congruence properties of p(n). Arithmetical functions: $\Phi(n)$, $\mu(n)$, $d(n)$, $\sigma(n)$. A particular Dirichlet series for Riemann Zeta Function.

Texts:

- I. N. Herstein. Topics in Algebra, Wiley, 2006
- I. Niven, H.S. Zuckerman, H.L. Montgomery. An introduction to the theory of numbers, Wiley, 2000

References:

- D.S. Dummit & R.M. Foote. Abstract Algebra, Wiley, 1999
- G.H. Hardy, E.M. Wright. An introduction to the theory of numbers, OUP, 2008
- T.M. Apostol. Introduction to Analytic Number Theory, Springer, UTM, 1998

INTRODUCTION TO COMPUTATIONAL TOPOLOGY

MA214	INTRODUCTION TO COMPUTATIONAL TOPOLOGY	3-0-0-6	Pre-requisites:Nil

1. Introduction and general notions of point set topology : Open and Closed Sets, Neighbourhoods, Connectedness
and Compactness, Separation, Continuity.
2. An overview of topology and classification of surfaces : Surfaces – orientable and non-orientable, their topology,
classification of closed suraces
3. Combinatorial Techniques : Simplicial complexes, and simplicial maps, triangulations, Euler characteristics,

Maps on
surfaces.
4. Homotopy and Homology Groups: Introducing Groups and concept of Homotopy, fundamental group and its calculations, Homology.
5. Calculating Homology : Computation of homology of closed surfaces.
6. 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

INTRODUCTION TO NUMERICAL METHODS

MA231	**INTRODUCTION TO NUMERICAL METHODS**	**3-0-0-6**	**Pre-requisites:Nil**

Number Representation and Errors: Numerical Errors; Floating Point Representation; Finite Single and Double Precision Differences; Machine Epsilon; Significant Digits.

Numerical Methods for Solving Nonlinear Equations: Method of Bisection, Secant Method, False Position, Newton-Raphson's Method, Multidimensional Newton's Method, Fixed Point Method and their convergence.

Numerical Methods for Solving System of Linear Equations: Norms; Condition Numbers, Forward Gaussian Elimination and Backward Substitution; Gauss-Jordan Elimination; FGE with Partial Pivoting and Row Scaling; LU Decomposition; Iterative Methods: Jacobi, Gauss Siedal; Power method and QR method for Eigen Value and Eigen vector.

Interpolation and Curve Fitting: Introduction to Interpolation; Calculus of Finite Differences; Finite Difference and Divided Difference Tables; Newton-Gregory Polynomial Form; Lagrange Polynomial Interpolation; Theoretical Errors in Interpolation; Spline Interpolation; Approximation by Least Square Method.

Numerical Differentiation and Integration: Discrete Approximation of Derivatives: Forward, Backward and Central Finite Difference Forms, Numerical Integration, Simple Newton-Cotes Rules: Trapezoidal and Simpson's (1/3) Rules; Gaussian Quadrature Rules: Gauss-Legendre, Gauss-Laguerre, Gauss-Hermite, Gauss-Chebychev.

Numerical Solution of ODE & PDE: Euler's Method for Numerical Solution of ODE; Modified Euler's Method; Runge-Kutta Method (RK2, RK4), Error estimate; Multistep Methods: Predictor-Corrector method, Adams-Moulton Method; Boundary Value Problems and Shooting Method; finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic partial differential equations.

Exposure to software package MATLAB.

Texts:

- K. E. Atkinson, Numerical Analysis, John Wiley, Low Price Edition (2004).
- S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 2005.

References:

- J. Stoer and R. Bulirsch, Introduction to Numerical Analysis, 2nd Edition, Texts in Applied Mathematics, Vol. 12, Springer Verlag, 2002.
- J. D. Hoffman, Numerical Methods for Engineers and Scientists, McGraw-Hill, 2001.
- M.K Jain, S.R.K Iyengar and R.K Jain, Numerical methods for scientific and engineering computation (Fourth Edition), New Age International (P) Limited, New Delhi, 2004.
- S. C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill 2008.

OPTIMIZATION TECHNIQUES

MA251	OPTIMIZATION TECHNIQUES	3-0-0-6	Pre-requisites:Nil

Introduction to linear and non-linear programming. Problem formulation. Geo- metrical 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).

Optics & Lasers

PH201	Optics & Lasers	3-0-0-6	Pre-requisites:Nil

Review of basic optics: Polarization, Reflection and refraction of plane waves. Diffraction: diffraction by circular aperture, Gaussian beams.

Interference: two beam interference-Mach-Zehnder interferometer and multiple beam interference-Fabry-Perot interferometer. Monochromatic aberrations. Fourier optics, Holography. The Einstein coefficients, Spontaneous and stimulated emission, Optical amplification and population inversion. Laser rate equations, three level and four level systems; Optical Resonators: resonator stability; modes of a spherical mirror resonator, mode selection; Q-switching and mode locking in lasers. Properties of laser radiation and some laser systems: Ruby, He-Ne, CO_2, Semiconductor lasers. Some important applications of lasers, Fiber optics communication, Lasers in Industry, Lasers in medicine, Lidar.

Texts:

- R. S. Longhurst, *Geometrical and Physical Optics*, 3rd ed., Orient Longman, 1986.
- E. Hecht, *Optics*, 4th ed., Pearson Education, 2004.
- M. Born and E. Wolf, *Principles of Optics*, 7th ed., Cambridge University Press, 1999.
- William T. Silfvast, *Laser Fundamentals*, 2nd ed., Cambridge University Press, 2004.

- K. Thyagarajan and A. K. Ghatak, *Lasers: Theory and Applications*, Macmillan, 2008.

Vacuum Science and Techniques

PH203	**Vacuum Science and Techniques**	**3-0-0-6**	**Pre-requisites:Nil**

Fundamentals of vacuum, units of pressure measurements, Gas Laws (Boyles, Charles), load-lock chamber pressures, Partial and Vapor Pressures, Gas flow, Mean free path, Conductance, Gauges, Capacitance Manometer, Thermal Gauges, Thermocouple, Pirani Gauge, Penning Gauge, High Vacuum Gauges, Leak Detection, Helium Leak Detection, Cold Cathode Gauge, Roughing (Mechanical) Pumps, Pressure ranges, High Vacuum Pumps: Oil Diffusion Pump, Tolerable fore line pressure System configuration, Oils, Traps Crossover pressure calculations, Pump usage and procedures, Turbomolecular pump, Cryopumps, Pump usages, Out gassing and Leak Testing.

Introduction to Deposition, Anti Reflection (AR) Coatings, Mono-dimensionally modulated (MDM) Filters, Vacuum Coatings, High reflectors, e-Beam deposition systems, Film Stoichiometry, Sputtering, Itching and Lithography, Chemical Vapour deposition and Pulse Laser deposition, Mass Flow control, Reactive sputtering, Film growth control.

Texts:

- K.L. Chopra and S.R. Das, *Thin Film Solar Cells*, Springer, 1983.
- Nagamitsu Yoshimura, *Vacuum Technology: Practice for Scientific Instruments*, Springer, 2008.
- Milton Ohring**,** *Materials Science of Thin Films*, Second Edition, Academic Press, 2001.

References:

- A. Roth, *Vacuum Technology*, North Holland, 1990.
- Donald Smith, *Thin-Film Deposition: Principles and Practice*, McGraw-Hill Professional, 1995.
- Krishna Shesan, *Handbook of Thin Film Deposition*, William Andrew, 2002.

Fourth Semester-HSS Electives

INTRODUCTORY MACROECONOMICS

HS202	**INTRODUCTORY MACROECONOMICS**	**3-0-0-6**	**Pre-requisites:Nil**

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

LITERATURE: VOICES AND CULTURES

HS211	**LITERATURE: VOICES AND**	**3-0-0-6**	**Pre-requisites:Nil**

CULTURES

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 Satthianadhan, Kamala, OUP, 1998
- Alice Walker,The Colour Purple, Houghton Miffin 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

LANGUAGE, HUMAN MIND, AND INDIAN SOCIETY

HS222	LANGUAGE, HUMAN MIND, AND INDIAN SOCIETY	3-0-0-6	Pre-requisites:Nil

Language: Form and function (Competence vs. Performance), Language as a rule-governed system, Language constitutive of being human; Languages of India: Language families (Genealogical classification of languages), India as a linguistic Area; Human mind: Cognitive language faculty, Biological foundations of language, Language acquisition, Human and non-human systems of communication, Construction of knowledge, Language processing, comprehension and production, Bilingualism and cognitive growth; Indian Society: Multilingualism vs. Bilingualism, India as a multilingual nation, Identities and language, Implications for pedagogy (Multilingual approaches to education), Language and dialect, Politics of language in India

Texts:

- M. Montgomery, An introduction to language and society, Routledge, 1986
- N.Chomsky, Language and Mind, Cambridge University Press, 2006
- V. Evans and M.C. Green, Cognitive linguistics: an introduction, Edinburgh University Press, 2006

References:

- J.R. Searle, Mind, language and society: philosophy in the real world, Basic Books, 1999
- A. Akmajian , R.A. Demers, A.K. Farmer, R.M. Harnish, Linguistics: an introduction to language and communication, Mass:MIT Press, 2001
- N.Chomsky, New horizons in the study of language and mind Cambridge University Press, 2000
- W. Corft and D. Alan Cruse, Cognitive linguistics Cambridge University Press, 2004

COGNITION: LANGUAGE AND COMPUTATION

HS223	COGNITION: LANGUAGE AND COMPUTATION	3-0-0-6	Pre-requisites:Nil

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. Friedenberg 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

Fifth Semester

ME301 Manufacturing Technology I

ME301	Manufacturing Technology I	3-1-0-8	Pre-requisites: Nil

Introduction to manufacturing processes: Moulding materials and their requirements. Patterns: types and various pattern of materials. Casting processes: Various foundry casting methods: viz. sand casting Investment casting, pressure die casting, centrifugal casting, continuous casting, thin roll casting, single crystal growth. Solidification of casting and flow properties of molten metal; Gating and risering systems, directional solidification, use of chills and chaplets, Casting defects and their remedies; Metal joining processes: brazing, soldering and welding; Solid state welding methods: resistance welding, arc welding; submerged arc welding, inert gas welding: Welding defects, inspection. Metal forming Processes: Various metal forming techniques and their analysis, viz Forging, rolling, Extrusion and wire drawing, Sheet metal working, Spinning, Swaging; super plastic deformation. Powder metallurgy and its applications

Text:

- James S Campbell, Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1995.
- F.C. Flemmings, Solidification processing, Tata McGraw Hill, 1982
- M J Rao, Manufacturing Technology: Foundry, Forming and Welding, Tata McGraw Hill, 1987.
- G E Linnert, Welding Metallurgy, AWS, 1994.
- P C Pandey and C K Singh, Production Engineering Sciences, Standard Publishers Ltd. 1980.
- R W Heine, C R Loper, and P C Rosenthal, Principles of Metal Casting, 2nd ed, Tata McGraw Hill, 1976.
- A Ghosh and A K Mallik, Manufacturing Science, Wiley Eastern, 1986.

ME302 Mechanical Measurements

ME302	Mechanical Measurements	2-1-0-6	Pre-requisites: Nil

Fundamental of Measurement: Elements of a generalized measurement system, standards, and types of signals. Static performance characteristics. Dynamic performance, instrument types - zero, first and second order instruments, transfer function representation, system response to standard input signals - step, ramp, impulse, and frequency response. Treatment of uncertainties: error classification, systematic and random errors, statistical analysis of data, propagation and expression of uncertainties. Measurement of various physical quantities: Linear and angular displacement, velocity, force, torque, strain, pressure, flow rate and temperature. Transfer functions of some standard measuring devices. Data Acquisition and processing: Digital methods, digitization, signal conditioning, interfacing, standard methods of data analysis - quantities obtainable from time series. Fourier spectra, DFT, FFT. Data acquisition parameters - sampling rate, Nyquist sampling frequency, aliasing & leakage errors. Metrology: measurement of angles, threads, surface finish, inspection of straightness, flatness and alignment, gear testing, digital readouts, coordinate measuring machine.

Text:

- Doebelin E.O., Measurement systems- Applications and Design, 4e, Tata McGraw-Hill, 1990.
- Beckwith T. G., Marangoni, R. D., and Lienhard, J. H., Mechanical Measurements, 5e, Addison Wesley, 1993.
- Figiola, R.S. and Beasley, D.E., Theory and design for mechanical measurements, 2(e), John Wiley, 1995.
- Dally, Riley, and McConnell, Instrumentation for engineering measurements, 2e, John Wiley & Sons, 1993.
- Doebelin E.O., Engineering Experimentation, McGraw-Hill, 1995.
- Jain R.K., Engineering Metrology, Khanna Publishers, New Delhi, 1997.

ME303 Design of Machine Elements

ME303	Design of Machine Elements	3-1-0-8	Pre-requisites: Nil

Principles of mechanical design; Factor of safety, strength, rigidity, fracture, wear, and material considerations; Stress concentrations; Design for fatigue; Limits and fits; Standardization; Design of riveted, bolted, and welded joints; Rigid and flexible couplings; Belt and chain drives; Power screws; Shafts; Keys; Clutches; Brakes; Axles; Springs.

Text:

- J. E. Shigley, Mechanical Engineering Design, McGraw Hill, 1989.
- Design Data, PSG Tech, Coimbatore, 1995
- M. F. Spotts, Design of Machine Elements, 6th ed., Prentice Hall, 1985
- A. H. Burr and J. B. Cheatham, Mechanical Analysis and Design, 2nd ed., Prentice Hall, 1997.

ME304 Kinematics of Machinery

ME304	Kinematics of Machinery	2-1-0-6	Pre-requisites: nil

Elements of kinematic chain, mechanisms, their inversions, mobility (Kutzhbach criteria) and range of movements (Grashof's law); Miscellaneous mechanisms: straight line generating mechanism, intermittent motion mechanism; Displacement, velocity and acceleration analysis of planar mechanisms by graphical, analytical and computer aided methods; Dimensional synthesis for motion; function and path generation; Cam profile synthesis and determination of equivalent mechanisms; Gears (spur, helical, bevel and worm); gear trains: simple, compound and epicyclic gearing.

Text:

- J. E. Shighley and J.J. Uicker, Theory of Machines and Mechanisms, McGraw Hill, 1995
- A. K. Mallik, A. Ghosh, G. Dittrich, Kinematic analysis and synthesis of Mechanisms, CRC, 1994.
- A. G. Erdman and G. N. Sandor, Mechanism Design, Analysis and Synthesis Volume 1, PHI, Inc., 1997.
- J. S. Rao and R. V. Dukkipati, Mechanism and Machine Theory, New Age International, 1992.
- S. S. Rattan, Theory of Machines, Tata McGraw Hill, 1993.
- T. Bevan. Theory of Machines, CBS Publishers and Distributors, 1984

ME305 Heat and Mass Transfer

ME305	Heat and Mass Transfer	3-1-0-8	Pre-requisites: nil

Modes of heat transfer; Conduction: 1-d, 2-d, and 3-d steady conduction, 1-d unsteady conduction - analytical /numerical / graphical solution methods, fins; Convection: fundamentals, order of magnitude analysis of momentum and energy equations, hydrodynamic and thermal boundary layers, dimensional analysis, free and forced convection, external and internal flows, heat transfer with phase change; Radiation: Stefan Boltzmann law, Planck's law, emissivity and absorptivity, radiant exchange between -NTU methods, heat transferεblack surfaces; Heat exchangers: LMTD and enhancement techniques, special heat transfer processes like transpiration and film cooling, ablative cooling; Mass transfer: molecular diffusion, Fick's law, equimolar counter diffusion, molecular diffusion in a stationary gas, analogy between heat and mass transfer, evaluation of mass transfer coefficients by dimensional analysis. Mass transfer in boundary layer, flow over a flat plate.

Text:

- F.P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 4e, John Wiley and Sons. 1996.
- J.P. Holman, Heat Transfer, 8e, McGraw Hill, 1997.
- M.N. Ozisik, Heat Transfer - A basic approach, McGraw Hill, 1985.
- A. Bejan, Convection Heat Transfer, 2e, Interscience, 1994.

ME310 Mechanical Engineering Laboratory- II

ME310	Mechanical Engineering Laboratory- II	0-0-4-4	Pre-requisites: nil

Metallography: microscopic techniques, determination of volume fraction of different phases in material including metals, estimation of grain sizes, study of heat affected regions in welded steel specimen; Machining processes: Measurement of tool angles and radius for single point cutting tool, determination of cutting forces, shear plane, chip thickness ratio, profile estimation using profile projector;
Demonstration of various mechanisms and gear systems;
Experiments in conduction, free and forced convection, heat exchangers, petrol and diesel engines.

ME321 Applied Thermodynamics I

ME321	Applied Thermodynamics I	2-1-0-6	Pre-requisites: nil

Vapour Power Cycles: Carnot cycle, Rankine cycle, reheat cycle, regenerative cycle, steam cycles for nuclear power plant, back-pressure and extraction turbines and cogeneration, low-temperature power cycles, ideal working fluid and binary/multi-fluid cycles; Steam Generator: subcritical and supercritical boilers, fluidized bed boilers, fire-tube and water-tube boilers, mountings and accessories; Condenser; Cooling Tower: hygrometry and psychrometric chart; Steam Turbine: impulse and reaction stage, degree of reaction, velocity triangle, velocity and pressure compounding, efficiencies, reheat factor, governing, nozzles; Heat Pump and Refrigeration Cycles: reversed Carnot cycle and performance criteria, vapour compression and vapour absorption refrigerators, gas cycles, refrigerants and environmental issues; Air-conditioning; Reciprocating Air Compressors: work transfer, volumetric efficiency, isothermal efficiency, multistage compression with intercooling.

Text:

- G F C Rogers and Y R Mayhew, Engineering Thermodynamics Work and Heat Transfer 4e, Pearson, 2003.
- T D Eastop and A McConkey, Applied Thermodynamics for Engineering Technologists, 5e, Pearson, 2003.
- M J Moran and H N Shapiro, Fundamentals of Engineering Thermodynamics 3e, John Wiley, 1995.
- M M ElWakil, Power Plant Technology, McGraw Hill International, 1992.
- P K Nag, Powerplant Engineering, Tata McGraw Hill, 2e, 2002.

Fifth Semester - Open Electives

ENTREPRENEURSHIP

HS351	ENTREPRENEURSHIP	3-0-0	

Topic: Introduction
Understanding Entrepreneurship: Entrepreneurship & Economic Growth. The Entrepreneurial Method –Effectual & Casual, Myths of Entrepreneurship Idea, Generation Exercise

Topic: Accounting and Finance
Form of Business Organization
Generally accepted Accounting Principles (GAAP)
Rules of Double-Entry Accounting
Type of Financial Statement & Relationship of Financial Statements
Preparation of Accounting Statements
Preparing Final Plan
Valuation of New Ventures
Venture Capital Financing

Topic: Sales and Marketing
What is Marketing? Marketing Concepts, Framework of Marketing? 4Ps of Marketing, Socio-cultural, Legal and Regulatory, Economics, Ethical, Political and Social Responsibility Dimension to Marketing
Understanding target markets, segmentation
Marketing Research
Consumer Behaviour: includes consumer behaviour, models, motivation, perception, attitudes and the influences of family, society and cultural
Product
Understanding Innovation
Sales Forecasting Pricing
Strategies Promotion and
Advertising
Marketing Strategies and Marketing Plans

Topic: Business Plan Project
Starting-up: Who do you start with (Apple), When to start (Lemon Tree), Talking the Plunge (Affordable loss Principle), Bootstrapping (Bird in Hand), Partnership (R & R), Start-up Problems
The Business Plan: Need for a Business Plan, What stake-holders look for, Making a Business Plan. Presenting Business Plan
Early Growth: Scaling-up, Legal Issues, Financial Issues, Human Issues, Adoption Model – Crossing the Chasm, Marketing or Entrepreneurs
The High Growth Venture: From effectuation to causation, Problems of Growth, Ownership & Control, Harvesting
Entrepreneurship and related Issues: E-commerce, Franchising, Family Business, Entrepreneurship within corporate

Industrial Waste Treatment and Management

CE315	**Industrial Waste Treatment and Management**	**3-0-0-6**	**Pre-requisites:Nil**

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 Books:

- 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.

Introduction to Infotainment

CS381	Introduction to Infotainment	3-0-0-6

Introduction to Infotainment Systems – Overview, Components
Information based Services – Localization and Context based Advertisements, Online Social Networking, Crowdsourcing. Information retrieval, Context awareness, Information dissemination and Information diffusion in these systems.
Entertainment based Services – Audio and video conferencing, Video-on-Demand, Video Streaming etc, Mobile multimedia applications, Online Games.
Architectural Support – Deployment strategies for these multimedia services, Content delivery networks, peer-to-peer based deployment, Performance metrics, Strategies for improving performance.
Implementation Tools – Tools for animation designing, movie making, Introduction to Android programming. Reading mobile sensor information, group formation and handling data services on Android Platforms.
Case Studies – In-vehicle Infotainment Systems, In-flight Infotainment Systems etc.

Text / Reference Books:

- Stefan Steiniger, Moritz Neun and Alistair Edwardes, Foundations of Location Based Services. http://ftp.jaist.ac.jp/pub/sourceforge/j/project/ju/jump-pilot/w_other_freegis_documents/articles/lbs_lecturenotes_steinigeretal2006.pdf
- X.-S. Hua, T. Mei, and A. Hanjalic, Online Multimedia Advertising: Techniques and Technologies. IGI Global, 2011
- Social Network Data Analytics, Ed. Charu C. Agarwal, Kluwer Academic Publisher.
- Gediminas Adomavicius and Alexander Tuzhilin, Context Aware Recommender Systems, http://ids.csom.umn.edu/faculty/gedas/nsfcareer/CARS-chapter-2010.pdf
- F. Thouin and M. Coates, Video-on-Demand Networks: Design Approaches and Future Challenges, *Network, IEEE , vol.21, no.2, pp.42,48, March-April 2007*
- Novella Bartolini, Emiliano Casalicchio and Salvatore Tucci, A Walk through Content Delivery Networks, *Performance Tools and Applications to Networked Systems*, *Lecture Notes in Computer Science Volume 2965, 2004, pp 1-25*
- Xiangyang Zhang, Hossam Hassanein, A survey of peer-to-peer live video streaming schemes – An algorithmic perspective, *Computer Networks, Volume 56, Is, sue 15, 15 October 2012*
- Android Programming http://developer.android.com/training/index.html
- Papers from reputed journals and conferences.

Sixth Semester-Core Courses

ME306 Manufacturing Technology IIs

ME306	Manufacturing Technology IIs	3-1-0-8	Pre-requisites: nil

Metal Cutting: mechanics, tools (material, temperature, wear, and life considerations), geometry and chip formation, surface finish and machinability, optimization; Machine tool: generation and machining principle s, Setting and Operations on machines : lathe, milling (including indexing), shaping, slotting, planing, drilling,

boring, broaching, grinding (cylindrical, surface, centreless), thread rolling and gear cutting machines; Tooling: jigs and fixtures, principles of location and clamping; Batch production: capstan and turret lathes; CNC machines, Finishing: microfinishing (honing, lapping, superfinishing); Unconventional methods: electro-chemical, electro-discharge, ultrasonic, LASER, electron beam, water jet machining, Rapid prototyping and rapid tooling.

Text:

- G Boothroyd, Fundamentals of Metal Cutting Machine Tools, Tata McGraw Hill, 1975.
- Production Technology, H M T Publication Tata McGraw Hill, 1980.
- P C Pandey and C K Singh, Production Engineering Sciences, Standard Publishers Ltd. 1980.
- A Ghosh and A K Mallik, Manufacturing Science, Wiley Eastern, 1986.

ME307 Machine Design

ME307	Machine Design	3-1-0-8	Pre-requisites: nil

Design of Gears; Lubrication and Wear consideration in Design; Design and selection of Bearings: Hydrodynamic lubrication theory, Hydrostatic and Hydrodynamic bearings (e.g., journal), Rolling Element Bearings; Systems Approach to Design: Decision Making, Simulation of mechanical systems using CAD tools, Sensitivity analysis of design parameters, Value Analysis and Value Addition to designed components and systems; Exercises of mechanical systems design with examples; Overview of Optimization in Design; Reliability and Robust Design; Communicating the Design;

Text:

- J. E. Shigley, Mechanical Engineering Design, IS Metric ed., McGraw Hill, 1986.
- Design Data, PSG Tech, Coimbatore, 1995
- M. F. Spotts, Design of Machine Elements, 6th ed., Prentice Hall, 1985
- V. Ramamurti, Computer Aided Mechanical Design and Analysis, 3rd ed., Tata McGraw Hill, 1996
- A. H. Burr and J. B. Cheatham, Mechanical Analysis and Design, 2nd ed., Prentice Hall, 1997.
- John R Dixon, Design Engineering: Inventiveness, Analysis and Decision Making, TMH, New Delhi, 1980.

ME308 Dynamics of Machinery

ME308	Dynamics of Machinery	2-1-0-6	Pre-requisites: nil

Static and dynamic force analysis; Flywheel; inertia forces and their balancing for rotating and reciprocating machines; Gyroscope and gyroscopic effects; Governers: types and applications; Cam dynamics: analysis of cam and follower, jump phenomenon; Vibrations of one degree of freedom systems; Free and Force vibrations;

Transverse and torsional vibrations of two and three rotor systems; critical speeds; Vibration isolation and measurements; two-degree of freedom systems; Geared system; Introduction to Multi-degree of Freedom System :normal mode vibration, coordinate coupling, forced harmonic vibration, vibration absorber (tuned, and centrifugal pendulum absorber), vibration damper; Properties of vibrating system, flexibility matrix, stiffness matrix, reciprocity theorem, eigenvalues and eigenvectors, orthogonal properties of eigenvectors, modal matrix, Rayleigh damping, Normal mode summation.

Text:

- J. E. Shighley and J.J. Uicker, Theory of Machines and Mechanisms, McGraw Hill, 1995
- J. S. Rao and R. V. Dukkipati, Mechanism and Machine Theory, New Age International, 1992.
- S. S. Rattan, Theory of Machines, Tata McGraw Hill, 1993.
- T. Bevan. Theory of Machines, CBS Publishers and Distributors, 1984
- L. Meirovitch, Elements of Vibration Analysis, McGraw Hill, 1998.
- W. T. Thomsom and Dahleh, M. D., Theory of Vibration with Applications, 5th ed., Pearson Education, 1999

ME309 Control Systems

ME309	Control Systems	3-1-0-8	Pre-requisites: nil

Feedback systems, mathematical modelling of physical systems; Laplace transforms, block diagrams, signal flow graphs, state-space models; Time domain analysis: performance specifications, steady state error, transient response of first and second order systems; Stability analysis: Routh-Hurwitz stability criterion, relative stability; proportional, integral, PI, PD, and PID controllers; Lead, lag, and lag-lead compensators; Root-locus method: analysis, design; Frequency response method: Bode diagrams, Nyquist stability criterion, performance specifications, design; State-space methods: analysis, design; Physical realizations of controllers: hydraulic, pneumatic, and electronic controllers.

Text:

- K Ogata, Modern Control Engineering, 4th ed, Pearson Education Asia, 2002.
- B C Kuo and F. Golnaraghi, Automatic Control Systems, 8th ed, John Wiley (students ed.), 2002.
- M Gopal, Control Systems: Principles and Design, 2nd ed, TMH, 2002.
- M Gopal, Modern Control System Theory, 2nd ed., New Age International, 1993.
- R. C. Dorf and R. H. Bishop, Modern Control Systems, 8th ed., Addison Wesley, 1998.
- P. Belanger, Control Engineering: A modern approach, Saunders College Publishing, 1995.

ME311 Mechanical Engineering Laboratory- III

ME311	**Mechanical Engineering Laboratory- III**	**0-0-4-4**	**Pre-requisites: nil**

Theory of machines: Static and dynamic balancing (multi-plane) of rotary systems, gyroscope, governors, whirling of shafts, simple and compound pendulums, determination of moment of inertia using trifilar suspension, torsional vibration; Metrology: Use of various metrological tools like slip, angle gauge, feeler, taper, fillet, thread gauges, estimation of internal dimensions; CNC machine trainer, CNC coding; Turbomachinery: Centrifugal and positive displacement pumps, Pelton and propeller turbines.

ME322 Applied Thermodynamics II

ME322	**Applied Thermodynamics II**	**2-1-0-6**	**Pre-requisites: nil** I.

C. Engines: Classification - SI, CI, two-stroke, four-stroke etc., operating characteristics - mean effective pressure, torque and power, efficiencies, specific fuel consumption etc., air standard cycles - Otto, Diesel and dual, real air-fuel engine cycles, Thermochemistry of fuels - S.I. and C.I. engine fuels, self ignition, octane number, cetane number, alternate fuels etc., combustion - combustion in S.I. and C.I. engines, pressure-crank angle diagram, air-fuel ratio, chemical equation and conservation of mass in a combustion process etc., Air and fuel inje ction - injector and carburetor, MPFI etc., ignition, lubrication, heat transfer and cooling; Gas Power Cycles: Simple gas turbine cycle - single and twin shaft arrangements, intercooling, reheating, regeneration, closed cycles, optimal performance of various cycles, combined gas and steam cycles; Introduction to Axial-Flow Gas Turbine; Introduction to Centrifugal and Axial-Flow Compressors; Combustion Chambers; Jet Propulsion: turbojet, turboprop, turbofan, ramjet, thrust and propulsive efficiency; Rocket Propulsion; Direct Energy Conversion: thermionic and thermoelectric converters, photovoltaic generators, MHD generators, fuel cells.

Text:

- G F C Rogers and Y R Mayhew, Engineering Thermodynamics Work and Heat Transfer 4e, Pearson, 2001.
- H I H Saravanamuttoo, G F C Rogers and H. Cohen, Gas Turbine Theory 4e, Pearson, 2003
- T D Eastop and McConkey, Applied Thermodynamics for Engineering Technologists 5e, Pearson, 1999.
- W W Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine , PHI, 2002.
- C R Fergusan and A T Kirkpatrick, Internal Combustion Engines, John Wiley & Sons, 2001.

Sixth Semester-HSS Electives

Diasporic Literature

HS311	**Diasporic Literature**	**3-0-0-6**	**Pre-requisites: nil**

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:

- Janmejay 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*, IIAS, Shimla, 1996.
- Vijay Mishra, Diasporic Imaginary: Theorizing the Indian Diaspora from *Textual Practice 10 (3)*, 1996, 421-447

Sociology of Development

HS331	Sociology of Development	3-0-0-6	Pre-requisites: nil

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.)

Texts/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

Seventh Semester - Core Courses

ME400 Summer Training

ME400	Summer Training	0-0-0-2	Pre-requisites: nil

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.

ME401 Industrial Engineering and Operations Research

ME401	Industrial Engineering and Operations Research	3-1-0-8	Pre-requisites: nil

Introduction, Production Planning and Control, Product design, Value analysis and value engineering, Plant location and layout, Equipment selection, Maintenance planning, Job, batch, and flow production methods, Group technology, Work study, Time and motion study, Incentive schemes, Work/job evaluation, Inventory control, Manufacturing planning: MRP, MRP-II, JIT, CIM, Quality control, Statistical process control, Acceptance sampling, Total quality management, Taguchi's Quality engineering. Forecasting, Scheduling and loading, Line balancing, Break-even analysis. Introduction to operations research, linear programming, Graphical method, Simplex method, Dual problem, dual simplex method, Concept of unit worth of resource, sensitivity analysis, Transportation problems, Assignment problems, Network models: CPM and PERT, Queuing theory.

Text:

- S L Narasimhan, D W McLeavey, P J Billington, Production, Planning and Inventory Control, Prentice Hall, 1997.
- J L Riggs, Production Systems: Planning, Analysis and Control, Wiley, 3rd ed., 1981.
- A Muhlemann, J Oakland and K Lockyer, Productions and Operations Management, Macmillan, 1992.
- H A Taha, Operations Research - An Introduction, Prentice Hall of India, 1997.
- J K Sharma, Operations Research, Macmillan, 1997.

ME411 Mechanical Engineering Laboratory- IV

ME411	Mechanical Engineering Laboratory- IV	3-1-0-8	Pre-requisites: nil

Instrumentation and control: Proportional, integral, PI, PD, and PID controllers, lead, lag, and lag-lead compensators, hydraulic, pneumatic, and electronic controllers; Tribology: Performance of air bearings, friction and wear testing under different operating conditions, optical viscometry; Vibration: Experiments on single and multi degree of freedom systems, modal and frequency response analysis, vibration isolation, random vibrations; Acoustics: Measurement of sound pressure level with various frequency weightings, sound power estimation with sound pressure pressure level; Signals and Systems: Time domain and spectral analysis with software such as MATLAB; determination of FFT, PSD; effects of sampling, windowing, leakage, averaging.

ME498 Project - I

ME498	Project - I	0-0-8-8	Pre-requisites: nil

Seventh Semester - Departmental Electives

ME441 Computational Fluid Dynamics

ME441	Computational Fluid Dynamics	3-0-0-6	(Knowledge in C/Fortran programming is desired but not essential)

Concept of Computational Fluid Dynamics: Different techniques of solving fluid dynamics problems, their merits and demerits, governing equations of fluid dynamics and boundary conditions, classification of partial differential equations and their physical behaviour, Navier-Stokes equations for Newtonian fluid flow, computational fluid dynamics (CFD) techniques, different steps in CFD techniques, criteria and essentialities of good CFD techniques.

Finite Difference Method (FDM): Application of FDM to model problems, steady and unsteady problems, implicit and explicit approaches, errors and stability analysis, stream function-vorticity method, equation solver: direct and iterative solvers, introduction to gradient based solvers and packages, FDM for solving Navier-Stokes equation. Finite Volume Method (FVM): FVM for diffusion, convection-diffusion problem, different discretisation schemes, FVM for solving Navier-Stokes equation, FVM for unsteady problems. Numerical Grid Generations: Structured and unstructured, uniform and non-uniform grids, different techniques of grid generations, curvilinear grid generation. **Texts/References:**

- J. D. Anderson, Computational Fluid Dynamics, McGraw-Hill Inc., 1995.
- S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Pub, 1980.
- D. A. Anderson, J.C. Tannehill and R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Hemisphere Pub, 1984
- M. Peric and J. H. Ferziger, Computational Methods for Fluid Dynamics, Springer, 2001.

- H.K. Versteeg and W. Malalaskera, An Introduction to Computational Fluid Dynamics, Dorling Kindersley (india) Pvt Ltd,2008.
- C. Hirsch, Numerical Computation of Internal and External Flows, Butterworth-heinemann, 2007.
- P.S. Ghoshdastidar, Computer Simulation of Flow and Heat Transfer, Tata-McGrawhill, 1998.

ME443 Dynamics of Structural Members

ME443	Dynamics of Structural Members	3-0-0-6	Pre-requisites: ME 308, ME 309

Elementary concepts of analytical mechanics: Hamilton's principle, Lagrange's equation. Equations of motion for free and forced vibration of distributed parameter systems: axial vibration of a bar, transverse vibration of a string, torsional vibration of a shaft, transverse vibration of beams. Boundary-value problem and boundary conditions. Differential eigenvalue problem, eigenfunction and natural modes. Orthogonality of eigenfunctions and expansion theorem. Rayleigh quotient. Response to initial conditions and external excitations. Discretization of distributed parameter system: Galerkin's method, Rayleigh-Ritz method. General equations of motion for disretized linear time-invariant (LTI) systems. Algebraic eigenvalue problem, eigenvalue and eigenvectors, bi-orthogonal properties of eigenvectors. Orthogonal transformation and diagonalization of system matrices. Modal analysis of general LTI system described in state space. Lyapunov's definition of stability, asymptotic and exponential stability. Methods for numerical computation of eigenvalues. Solution of equation of motion using state-transition matrix. Control of structural vibration. Controllability and observability. Concept of optimal control. Modal control. **Texts/References:**

- L. Meirovitch, Fundamentals of Vibration, McGraw Hill, 2000.
- L. Meirovitch, Dynamics and Control of Structures, John Wiley & Sons, 1990.
- W.T. Thompson, M.D. Dahleh, C. Padmanabhan, Theory of Vibration with Application, 5th Ed., Pearson, 2008
- S.S. Rao, Mechanical Vibration, 4th Ed., Pearson, 2004.
- W. J. Palm III, Mechanical Vibration, John Willey and Sons, 2007.
- W. Weaver, Jr., S.P. Timoshenko, D.H. Young, Vibration Problems in Engineering, 5th Ed., John Wiley and Sons, 1990.
- K. Ogata, Modern Control Engineering, 5th Ed., Prentice Hall India, 2010.
- A. Tewari, Modern Control Design with MATLAB and SIMULINK, John Wiley & Sons, 2005.

ME445 Finite Element Method

ME445	Finite Element Method	3-0-0-6	Pre-requisites: Nil

Introduction, weak formulations, weighted residual methods, linear and bilinear Forms, variational formulations, weighted residual, collocation, subdomain, least square and Galerkin's method, Second-order differential equations in one dimension, Basis steps, discretization, element equations, linear and quadratic shape functions, assembly, local and global stiffness matrix and its properties, boundary conditions, penalty approach, multipoint constraints, applications to solid mechanics, heat and fluid mechanics problems, axisymmetric problems, Plane truss, local and global coordinate systems, stress calculations, temperature effect on truss members, Euler Bernoulli beam element, Hermite cubic spline functions, frame element, solution of practical problems, Formulation, FEM models, semidiscrete FEM models, Time approximation schemes, Applications, problems, Single variables in 2-D, triangular and rectangular elements, constant strain triangle, isoparametric formulation, higher order elements, six node triangle, nine node quadrilateral, master elements, modelling considerations, numerical integration, approximations errors, convergence and accuracy computer implementation, Torsion, heat transfer, heat transfer in thin fins, potential flow problems, axisymmetric problems, impositions of essential BCs, Review of equations of elasticity, stress-strain and strain-displacement relations, plane stress and plane strain problems, velocity pressure formulation, LMM and PM model, examples. **Texts/References:**

- J.N. Reddy, An Introduction to Finite Element Methods", 3rd Ed., Tata McGraw-Hill, 2005.
- O. C. Zienkiewicz, The Finite Element Method, 3rd Edition, Tata McGraw-Hill, 2002.
- K.D. Cook, D.S. Malkus and M.E. Plesha, Concept and Applications of Finite Element Analysis", 3th Ed., John Wiley and Sons, 1989.
- S.S.Rao, The Finite Element Method in Engineering, 4th Ed., Elsevier Science, 2005.
- J.N. Reddy and D.K. Gartling, The Finite Element Method in Heat Transfer and Fluid Dynamics, 2rd Ed., CRC Press, 2001.
- J. Fish and T. Belytschko, A First Course in Finite Elements, 1st Ed., John Wiley and Sons, 2007.
- J. Chaskalovic, Finite Element Methods for Engineering Sciences, 1st Ed., Springer, 2008.

ME447 Laser Material Processing

ME447	Laser Material Processing	3-0-0-6	Pre-requisites: ME202, ME305

Laser Fundamentals: Stimulated Emission, Population Inversion, Amplification, Optical Cavity Design. Laser Beam Characteristics -Wavelength, Coherence, Polarization, Mode and Beam Diameter; Optical Components and Design of Beam Delivery Systems. Types of Industrial Lasers and their Output Characteristics: Solid-Sate Lasers, Gas Lasers, Semiconductor Lasers, Liquid Dye Lasers. Laser Materials Interactions: Absorption of Laser Radiation, Absorption Characteristics of Materials; Thermal Effects - Heating, Melting and Vaporization; Plasma Formation; Ablation. Laser Cutting and Drilling: Material Removal Modes, Effects of Process Parameters, Development of Theoretical Models. Laser Welding: Process Mechanisms - Keyholes and Plasmas, Operating Characteristics, Process Variations. Laser Surface Modification: Heat Treatment, Rapid Solidification, Alloying and Cladding, Surface Texturing, Development of Theoretical Models, LCVD, LPVD. Laser Rapid Prototyping: Classification of RP Processes, Laser Based RP Processes, Applications. Laser Micromachining: Mechanisms, Techniques and Applications. Special Topics: Laser Interference Processing, Laser Shock Processing.
Texts/References:

- W. M. Steen and J. Mazumder, Laser Material Processing, 4'th Edition, Springer, 2010.
- E. Kannatey-Asibu, Principles of Laser Materials Processing, , Wiley, 2009.
- N. B. Dahotre and S P Harimkar, Laser Fabrication and Machining of Materials, Springer, 2008.
- John C. Ion, Laser Processing of Engineering Materials, Elsevier, 2005.
- J. F. Ready (Editor), LIA Handbook of Laser Materials Processing, Springer, 2001.
- M. von Allmen and A . Blatter, Laser-Beam Interactions with Materials, 2'nd Edition, Springer, 1998.

ME449 Refrigeration and Air Conditioning

ME449	Refrigeration and Air Conditioning	3-0-0-6	Pre-requisites: Nil

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.

ME461 Robotics and Robot Applications

ME461	Robotics and Robot Applications	3-0-0-6	Pre-requisites: Nil

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.

ME501 Robotics:Advanced Concepts and Analysis

ME501	Robotics: Advanced Concepts and Analysis	3-0-0-6	Pre-requisites:Nil

Introduction to robotics: brief history, types, classification and usage and the science and technology of robots.
Kinematics of robot: direct and inverse kinematics problems and workspace, inverse kinematics solution for the general 6R manipulator, redundant
and over-constrained manipulators.
Velocity and static analysis of manipulators: Linear and angular velocity, Jacobian of manipulators, singularity, static analysis.
Dynamics of manipulators: formulation of equations of motion, recursive dynamics, and generation of symbolic equations of motion by a computer simulations of robots using software and commercially available packages.
Planning and control: Trajectory planning, position control, force control, hybrid control
Industrial and medical robotics: application in manufacturing processes, e.g. casting, welding, painting, machining, heat treatment and nuclear power stations, etc; medical robots: image guided surgical robots, radiotherapy, cancer treatment, etc;
Advanced topics in robotics: Modelling and control of flexible manipulators, wheeled mobile robots, bipeds, etc. Future of robotics.
Reference Books

- 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).
- A. Ghosal, Robotics: “Fundamental Concepts and Analysis”, Oxford University Press (2008).
- Pires, “Industrial Robot Programming–Building Application for the Factories of the Future”, Springer (2007).
- Peters, “Image Guided Interventions – Technology and Applications”, Springer (2008).
- K. S. Fu, R. C. Gonzalez and C.S.G. Lee, “ROBOTICS: Control, Sensing, Vision and Intelligence”, McGraw-Hill (1987).
- J. J. Craig, “Introduction to Robotics: Mechanics and Control”, 2nd edition, Addison-Wesley (1989).

ME503 COMPUTATIONAL FLUID DYNAMICS

ME503	COMPUTATIONAL FLUID DYNAMICS	3-0-0-6	Pre-requisites:Nil

Concept of Computational Fluid Dynamics: Different techniques of solving fluid dynamics problems, their merits and demerits, governing equations of fluid dynamics and boundary conditions, classification of partial differential equations and their physical behavior, Navier-Stokes equations for Newtonian fluid flow, computational fluid dynamics (CFD) techniques, different steps in CFD techniques, criteria and essentialities of good CFD techniques.
Finite Difference Method (FDM): Application of FDM to model problems, steady and unsteady problems, implicit and explicit approaches, errors and stability analysis, direct and iterative solvers. Finite Volume Method (FVM): FVM for diffusion, convection-diffusion problem, different discretization schemes, FVM for unsteady

problems.
Prediction of Viscous Flows: Pressure Poisson and pressure correction methods for solving Navier-Stokes equation, SIMPLE family FVM for solving Navier-Stokes equation, modelling turbulence.
CFD for Complex Geometry: Structured and unstructured, uniform and non-uniform grids, different techniques of grid generations, curvilinear grid and transformed equations.
Lattice Boltzman and Molecular Dynamics: Boltzman equation, Lattice Boltzman equation, Lattice Boltzman methods for turbulence and multiphase flows, Molecular interaction, potential and force calculation, introduction to Molecular Dynamics algorithms.
Text Book/ Reference Books:

- J. D. Anderson, "Computational Fluid Dynamics", McGraw-Hill Inc. (1995).
- S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Pub. (1980).
- K. Muralidhar, and T. Sundarajan, "Computational Fluid Flow and Heat Transfer", Narosa (2003).
- D. A. Anderson, J. C. Tannehill and R. H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", Hemisphere Pub. (1984).
- M. Peric and J. H. Ferziger, "Computational Methods for Fluid Dynamics", Springer (2001).
- H. K. Versteeg and W. Malalaskera, "An Introduction to Computational Fluid Dynamics", Dorling Kindersley (India) Pvt. Ltd. (2008).
- C. Hirsch, "Numerical Computation of Internal and External Flows", Butterworth-Heinemann, (2007).
- J. M. Jaile, "Molecular Dynamics Simulation: Elementary Methods", Willey Professional, 1997.
- A. A. Mohamad, "Lattice Boltzman Method: Fundamentals and Engineering Applications withComputer Codes", Springer (2011).

ME541 Turbulent Shear Flows

ME541	Turbulent Shear Flows	3-0-0-6

Students who may find this course useful: PhD, M. Tech and 3rd/4th–year B. Tech. Students from Mechanical, Civil and Chemical Engineering Departments.

Pre-requisite: ME204 (Fluid Mechanics I) of IIT Patna or an equivalent basic course in Fluid Mechanics

Course Contents:

1. Flow instability and transition to turbulence
2. Nature of turbulence
3. Indicial notation for tensors
4. Fourier transforms and Parseval's theorem
5. Governing equations of turbulence
6. Eulerian Lagrangian and Fourier descriptions of turbulence
7. Statistical description of turbulence (Reynolds-averaged Navier-Stokes and Reynolds stress evolution equations)
8. Kolmogorov's hypotheses
9. Filtered description of turbulence (Bridging methods and large eddy simulation)
10. Boundary layer flow and other important turbulent shear flows (wake, jet, channel flow, etc.)
11. Development of turbulence closure models (Boussinesq approximation and Reynolds-stress evolution equation closures)
12. Rapid distortion theory (RDT) of turbulence
13. Turbulence processes (Cascade, dissipation, material element deformation, mixing, etc.)

Texts/Reference books:

- Pope, S. B., Turbulent Flows, Cambridge University Press, 2000.
- Wilcox, D.C., Turbulence Modeling for CFD, D.C.W. Industries, 3rd Edition, 2006.
- White, F.M., Viscous Fluid Flow, TATA McGraw Hill, 2011
- Tennekes, H. and Lumley, J.L., A First Course in Turbulence, The MIT Press, 1972.

Seventh Semester - Open Electives

Foundations of Computer Science

CS401	Foundations of Computer Science	3-0-0-6	Pre-requisites: Nil

Probabilitic 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, Eigenvalues 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

Graphs, Groups and Network

MA410	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 Algorthim, 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

Introduction to Biomechanics

ME- 481	Introduction to Biomechanics	3-0-0-6	Pre-requisites: nil

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,Tentanization 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, viscocity 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.

Introduction to Nanomaterials

PH401	Introduction to Nanomaterials	3-0-0-6	Pre-requisites: nil

Introduction: Overview of Nanotechnology, Quantum effect, Naotechnology 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 Bhusan (Ed.), Springer-Verlag, Berlin, Heidelberg, 2004.
- Fundamentals of Microfabrication: Science of Miniaturization; M.J. Madou, CRC Press, 2ndEdition, 2002.
- Nanostructures & Nanomaterials: Synthesis, Properties and Aplications; 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.

Solid State Devices

PH402	Solid State Devices	3-0-0-6	Pre-requisites: nil

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 Waser (ed.), Wiley – VCH Publishers, 2003.
- Physics of Semiconductor Devices, S. M. Sze, John Wiley & Sons, 2nd edition, 1981.
- Microwave Devices & Circuits, Sammuel 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.

Large Scale Scientific Computation

MA511	Large Scale Scientific Computation

Introduction to sparse matrices, Storage Schemes, Permutations and Reorderings, , Sparse Direct Solution Methods. Iterative methos and Preconditioning Convergence Krylov Subspaces, Arnoldi's Method, GMRES, Symmetric Lanczos Algorithm, Conjugate Gradient Algorithm, Convergence Analysis, Block Krylov Methods, Preconditioned Conjugate Gradient, Preconditioned GMRES, Jacobi, SOR, and SSOR Preconditioners, ILU

Factorization Preconditioners, Block Preconditioners, Types of Partitionings,
Techniques, Direct Solution and the Schur Complement, Schur Complement Approaches, Full Matrix Methods, Graph Partitioning: Geometric Approach, Spectral Techniques.

Newton's method and some of its variations, Newton method in several dimension, continuation methods, conjugate direction method and Davidon-Fletcher-Powell Algorithms, Introduction to Non-linear Multigrid with applications.

HPC kernels (BLAS, multicore and GPU computing)

Texts/References:

- O. Axelsson, Iterative Solution Methods Cambridge Univ. Press, 1994.
- W. Hackbusch, Multigrid Methods and Applications. Springer-Verlag, 1985.
- J.M. Ortega and W.C. Rheinboldt, Iterative Solution of Nonlinear Equations in Several Variables.Academic Press, NY, 1970.
- C.W. Ueberrhuber, Numerical Computation : Methods, Software and Analysis. Springer-Verlag,Berlin, 1997.
- P. Wesseling, An Introduction to Multigrid Methods. John Wiley & Sons, 1992.
- Yousef Saad, Iterative Methods for Sparse Linear Systems, SIAM 2003.

ME581 Biomechanics and Biomechatronics

ME581	**Biomechanics and Biomechatronics**	**3-0-0-6**

Course Objective: After completion of this course the student should be able to

- Recognize different forces and couples acting on a Biological systems
- Should be able to unify the biological system as a Continuum and demarcate the different elements of Biological system such as Bone, Tendon, Cartilage, Smooth Muscle cells
- Analyze the growth, remodelling and residual stress- Application to Artery and Tumour
- Able to identify Instrumentaion technique - Biopotential (ECG, EEG, ENG) Measurement of Blood Flow, Blood pressure, Measurement of Respiratory System, Medical imaging (Colour X ray, Colour Doppler, MRI, CT, PET)
- Identification of Specialized Instrumentation Technique- Drug Delivery, Infant Incubators, Ventilators, Hemodialysis
- **Project Based Leaning**- a) select and apply appropriate design methodology b) generate a variety of conceptual designs c) demonstration of feasibility of the conceptual design with special emphasis on Biomedical Application.

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction to Biological System**	1
2.	**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 • Tentanization pulse in muscle fibers • Physiology and mechanical properties of bones- Bones as bidirectional fibers-nets and its stress response **Circulation system**	15

	• 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 • Physiological Effects of Electricity- Macro-Micro Shock Hazards	
3.	**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	**6**
4.	**Instrumentation Technique** • Measurement of Biopotential (ECG, EEG, ENG) • Measurement of Blood Flow • Blood pressure measurement • Measurement of Respiratory System • Medical imaging (Colour X ray, Colour Doppler, MRI, CT, PET)	**9**
5.	**Therapeutic and Prosthetic Devices and Instrumentation** • Drug Delivery • Infant Incubators • Ventilators • Hemodialysis • Surgical Instrumentation- Application to Trauma	**8**
6.	**Introduction to Biosensor** • Blood Glucose Sensors • Preliminary concepts of Enzyme and DNA based Biosensor	**3**
7.	Experimental Demonstration, Project evaluation and Guest lecture by Medical Professionals	**3**
	Total	**45**

Suggested Books:

S. No.	Name of Authors / Books / Publisher	Year of Publication
1.	Jay D. Humphrey and Sherry DeLange "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer; 1st Edition	2004
2.	Carl-Fredrik Mandenius and Mats Bjorkman "Biomechatronic Design in Biotechnology: A Methodology for Development of Biotechnological Products", Wiley; 1st Edition	2011
3.	*Stephen C. Cowin* and *Jay D. Humphrey* Edt. , "Cardiovascular Soft Tissue Mechanics ", Kluwer Academic Publishers	2000
4.	L. Gorton Edt. "Biosensors and Modern Biospecific Analytical Techniques" Elsevier Science; 1st. Edition	2005

5.	Y.F. **Al-Obaid**, F.N. **Bangash** and T.**Bangash**, "Trauma - An Engineering Analysis" Springer; 1st Edition	2007
6.	John G. Webster Edt. "Medical Instrumentation: Application and Design", Wiley; 3rd Edition	1997

Eighth Semester - Core Courses

Project-II

ME499	**Project-II**	**0-0-16-16**	**Pre-requisites: Nil**

Each student will undertake a sizeable project involving survey of literature, development of new techniques and/or implementation of systems, writing of reports etc. under the guidance of one or more faculty members.

Eighth Semester - Departmental Electives

Aerodynamics

ME442	**Aerodynamics**	**3-0-0-6**	**Pre-requisites: ME204, ME206**

Review of Fluid Mechanics: Navier-Stokes equations, Boundary layer theory, Potential flows, Concepts of lift and drag, Turbulence, Compressible flows, Shock and expansion waves

Incompressible Flow Applications: Incompressible flow over airfoils: Kutta condition, Kelvin's circulation theorem, Classical thin airfoil theory, Incompressible flow over finite wings: Prandtl's classical lifting line theory, Delta wings, Three-dimensional incompressible flows, Panel techniques.

Compressible Flow Applications: Subsonic compressible flow over airfoils: linear theory, critical Mach number and Drag-divergence Mach number, Supercritical Airfoil, Supersonic flows: Non-linear techniques. Elements of hypersonic flow.

Practical Applications: Flow over a complete airplane, Motion of kite and insect/bird, Motion of a Helicopter, Oscillating wings, Aerodynamics for high lift devices, High angle of attack aerodynamics.

Texts/References:

J. D. Anderson, *Fundamentals of Aerodynamics*, McGraw-Hill Inc. (Indian Edition), 2005.

- Josep Katz and Allen Plotkin, *Low-Speed Aerodynamics*, Cambridge University Press, 2001.
- Wei Shyy, Yongsheng Lian, Jian Tang and Dragos Viieru, *Aerodynamics of Low Reynolds Number Flyers*, Cambridge University Press, 2008

Composite Materials and Engineering

ME446	**Composite Materials and Engineering**	**3-0-0-6**	**Pre-requisites:Nil**

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 Laminae

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*, 2nd 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*, 2nd edition, CRC Press, 2007
- I.M. Daniel and O.Ishai, *Engineering Mechanics of Composite Materials*, 2nd 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*, 2nd 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*, 3rd 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.

Rotor Dynamics

ME448	**Rotor Dynamics**	**3-0-0-6**	**Pre-requisites:ME101, ME308**

Rotor-Bearing Interaction, Flexural Vibration, Critical Speeds of Shafts, Jeffcott Rotor Model, Unbalance Response, Effect of Damping, Campbell Diagram, Effects of Anisotropic Bearings, Unbalanced Response of an Asymmetric Shaft, Parametric Excitation, Gyroscopic Effects, Rotor with Non-central Disc, Rigid-rotor of Flexible Bearings, Stodola Model, Effect of Spin Speed on Natural Frequency, Forward and Backward Whirling Motion, Aerodynamic Effects, Rotor-shaft Continuum, Effect of Rotary Inertia and Shear-Deformation within the Shaft, Equivalent Discrete System, Finite Element model for Flexural Vibration, Torsional Vibration, Geared and Branched Systems, Transfer Matrix Model, Fluid Film Bearings: Steady State Characteristics of Bearings, Raynold's Equation, Oil-Whirl, Rigid And Flexible Rotor Balancing, Active Vibration Control of Rotor-Bearing System: Active Magnetic Bearing, Condition Monitoring of Rotating Machinery, Measurement Techniques

Texts:

- J. S. Rao, *Rotor Dynamics*, Third ed., New Age, New Delhi, 1996 (2009 reprint).
- M. J. Goodwin, *Dynamics of Rotor-Bearing Systems*, Unwin Hyman, Sydney, 1989.

References:

- E. Krämmer, *Dynamics of Rotors and Foundation*, Springer-Verlag, New York, 1993.
- G. Genta, *Dynamics of Rotating Systems*, Springer, New York, 2005.
- J.M. Vance, *Rotordynamics of Turbomachinery*, Wiley, New York, 1988.
- M.L. Adams, *Rotating machinery vibration: from analysis to troubleshooting*, Second ed., CRC Press, Boca Raton, 2010.
- J. Kicinski, *Rotor dynamics*, Tech. Book, New Delhi, 2010.
- D. Childs, *Turbomachinery Rotordynamics: Phenomena, Modeling and Analysis*, Wiley, New York, 1993.

Journals:

Journal of Vibration and Accoustics, Trans. ASME

Journal of Gas Turbine for Power, Trans. ASME

Journal of Applied Mechanics, Trans. ASME

Journal of Dynamic Systems Measurement and Control, Trans. ASME

Journal of Mechanical Design, Trans. ASME

Journal of Sound and Vibration, Elsevier

Mechanical Systems and Signal Processing, Elsevier

Mechanism and Machine Theory, Elsevier

Mobile Robotics

ME 512	**Mobile Robotics**	**3-0-0-6**	**Pre-requisites:MA102 at IITP & C**

Objectives: Mobile robots are now enabling human beings to physically reach and explore unchartered territories in the Universe. Be a place as distant as Mars, in abysmal depths of ocean, or shrouded by thick glaciers of Antarctic, mobile robots help exploring everything; yet this is just the beginning. Even in day to day life

autonomous cars hold a potential to revolutionize transportation and domestic mobile robots help humans in cleaning, elderly help, etc. National defense is an area replete with the use of mobile robots. This course will present various aspects of design, fabrication, motion planning, and control of intelligent mobile robotic systems. The focus of the course is distributed equally on the computational aspects and practical implementation issues and thereby leads to a well rounded training. The course will give students an opportunity to design and fabricate a mobile robotic platform and program it to apply learned theoretical concepts in practice as a semester long class project.

Proposed Syllabus:

Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability;

Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.

Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision based sensors, uncertainty in sensing, filtering;

Localization: Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, positioning beacon systems.

Introduction to planning and navigation: path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP);

Robotics Project: Students will work on a semester long project consisting of design, fabrication, and programming a mobile robotic platform.

Text / Reference Books:

- Melgar, E. R., Diez, C. C., Arduino and Kinect Projects: Design, Build, Blow Their Minds, 2012.
- R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011.
- Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.

Eighth Semester - Open Elective

Matrix Computation

MA412	Matrix Computation	3-0-0-6	Pre-requisites:Nil

Introduction to Direct Methods: Diagonalization, Jordan Canonical Forms, SVD and POD, Direct Method for solving linear systems and Application to BVP, Discritization 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.

Photovoltaics & Fuel Cell Technology

PH403	**Photovoltaics & Fuel Cell Technology**	**3-0-0-6**	**Pre-requisites:Nil**

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:

- 1. 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^{nd} ed.), C. S. Solanki, Prentice Hall of India, 2011.
- Solar Cell Device Physics, Stephen Fonash (2^{nd} ed.), Academic Press, 2010.
- Fuel Cell Technology, Nigel Sammes (ed.), 1^{st} 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.

Applied FEM for Industries

CE 504	Applied FEM for Industries	3-0-0-6	Pre-requisites:Nil

Introduction:

Continuum Mechanics, Conservation laws, Riemannian Geometry and stress- strain tensors, Constitutive equation, Potential-, Strain-, and Kinetic energies, Functionals and variational formulation, mathematical programming and weak solutions; Displacement method of FEM analyses.

Field equations: Elasticity, Structural Dynamics, Fluid Mechanics, electromagnetic fields

Alternative approaches: Hybrid FEM, Mixed FEM, Boundary Element Method, Boundary Error Element, Mesh-less methods, Galerkin's approach of error orthogonalization.

Error analyses: Algebraic and Integral inequalities; estimate of error; error bounds; Convergence, super-convergence,

Computer Packaging: Pre-, Post-processing and Turbo C, Analysis Programs in FRORTAN;

Applications (as per request): Rigid-flexible assembly (ME and Bio-Mechanics); Two-phase flow (ME & CE); Electro-magnetic application to wave-guides, MOSFET analyses (ECE); magnetic levitation (electrical), Vibration and control of quartz substrate using smart material; Stochastic FEM, etc.

Text / Reference Books:

- The Finite Element Method: Its Basis and Fundamentals, C. Zienkiewicz, R. L. Taylor, J.Z. Zhu; 6th Edition, 2005.
- Concepts and applications of finite element analysis, Robert Davis Cook.
- Lecture Notes.

Industrial Waste Treatment and Management

CE 442	Industrial Waste Treatment and Management	3-0-0-6	Pre-requisites:Nil

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 Books:

- 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.

Mobile Robotics

ME 512	**Mobile Robotics**	**3-0-0-6**	**Pre-requisites:MA102 at IITP & C**

Objectives:

Mobile robots are now enabling human beings to physically reach and explore unchartered territories in the Universe. Be a place as distant as Mars, in abysmal depths of ocean, or shrouded by thick glaciers of Antarctic, mobile robots help exploring everything; yet this is just the beginning. Even in day to day life autonomous cars hold a potential to revolutionize transportation and domestic mobile robots help humans in cleaning, elderly help, etc. National defense is an area replete with the use of mobile robots. This course will present various aspects of design, fabrication, motion planning, and control of intelligent mobile robotic systems. The focus of the course is distributed equally on the computational aspects and practical implementation issues and thereby leads to a well rounded training. The course will give students an opportunity to design and fabricate a mobile robotic platform and program it to apply learned theoretical concepts in practice as a semester long class project.

Proposed Syllabus:

Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability;
Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.
Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision based sensors, uncertainty in sensing, filtering;
Localization: Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, positioning beacon systems.
Introduction to planning and navigation: path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP);
Robotics Project: Students will work on a semester long project consisting of design, fabrication, and programming a mobile robotic platform.

Text / Reference Books:

- Melgar, E. R., Diez, C. C., Arduino and Kinect Projects: Design, Build, Blow Their Minds, 2012.
- R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011.
- Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.

Application of Probabilistic Methods in Engineering

CE 502	**Application of Probabilistic Methods in Engineering**	**3-0-0-6**	**Pre-requisites:MA225 / basic knowledge in Probability and Statistics**

Introduction:

Concept of risk, and uncertainty in engineering analysis and design; Fundamental of probability models.

Analytical models of random phenomena: Baysian Analysis, Analysis of variance (ANOVA); Application of central limit theorem, confidence interval, expected value, and return period.
Application of Monte Carlo simulation (MCS): Determination of function of random variables using MCS methods; Application of MCS in various engineering problems.
Probabilistic analysis and determination: i) Forces induced by earthquakes, ii) Forces induced by wind, iii) Forces induced by sea waves, iv) Load on vehicles induced through surface roughness of roads.
Methods of risk Analysis: Composite risk analysis; Direct integration method; Method using safety margin, reliability index and safety factor.
Introduction to reliability analysis: Application of Bayes theorem in real life problem; Reliability analysis of simple systems: serial, parallel and combined systems; First order uncertainty and reliability analysis (FORM), First order second moment (FOSM) and Advanced FOSM methods; Applications of risk and reliability analysis in engineering systems.

Application of probabilistic methods:i) Fluid-structure interaction, ii) Soil-structure interaction iii) Railways iv) Automobile industry, v) Offshore structure, vi) Hydraulic structure

Text / Reference Books:

- Scheaffer, R. L., Mulekar, M. S. and McClave, J. T., (2011): Probability and statistics for Engineers, Fifth Edition, Brooks / Cole, Cengage Learning.
- Ang, A. H-S., and Tang, W. H., (2006): Probability Concepts in Engineering, Volumes 1. John Wiley and Sons.
- Halder, A and Mahadevan, S., (2000): Probability, Reliability and Statistical Methods in Engineering Design, John Wiley and Sons.
- Rao, S.S., (1992): Reliability-Based Design, McGraw Hill, Inc.
- Harr, M.E., (1987): Reliability-Based Design in Civil Engineering. McGraw Hill, Inc.
- Ang, A. H-S, and Tang, W. H., (1975): Probability Concepts in Engineering Planning and Design, Volumes 2. John Wiley and Sons
- Benjamin, J., and Cornell. A., (1963): Probability, Statistics, and Decision for Civil Engineers. McGraw Hill.

Eighth Semester - HSS Elective

Fundamentals of Cognitive Science

HS421	Fundamentals of Cognitive Science	3-0-0-6	Pre-requisites:Nil

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 and 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.

Industrial and Organizational Psychology

HS441	Industrial and Organizational Psychology	3-0-0-6	Pre-requisites:Nil

Aim of the Course:

Today, many of the engineering students after passing out are joining some kind of organization. Therefore, they need to know how they will be successful as job applicants, trainees, employees, team players, and managers. This course will help them in knowing about all these and applying psychological principles in industries and organizations.

Course Contents:

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 and References:

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