INDIAN INSTITUTE OF TECHNOLOGY PATNA

Syllabus – Semester VII

B.Tech. in Computer Science and Engineering

Sl. No.	Sem	Subject Code	Name of the subject	L	T	P	C
Core Courses							
1	VII	CS400	Summer Training	0	0	0	2
2	VII	CS421	Computer Peripherals and Interfacing	3	0	0	6
3	VII	CS422	Peripherals and Interfacing Laboratory	0	1	3	5
4	VII	CS498	Project	0	0	10	10
Departmental Elective Courses							
5	VII	CSxxx	Departmental Elective I	3	0	0	6
6	VII	CSxxx	Departmental Elective II	3	0	0	6
Open Elective Courses							
7	VII	XX4xx	Open Elective - I	3	0	0	6
			Total	**12**	**1**	**13**	**41**

List of Departmental Elective Courses for Computer Science and Engineering:

Sl. No.	Sem	Subject Code	Name of the Subject	L	T	P	C
1	VII	CS461	Artificial Intelligence	3	0	0	6
2	VII	CS443	Distributed Systems	3	0	0	6
3	VII	CS441	Topics in Databases	3	0	0	6

CS-400 Summer Training (0 0 0 2)
Prerequisites: 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.

CS 421 Computer Peripherals and Interfacing (3 0 0 6)
Prerequisites: CS222

Introduction to architectural details of 8/16/32 bit microprocessors and their programming. Interfacing microprocessors with devices such as displays, keyboard, DAC & ADC's etc. using programmable chips like I/O ports, timer/counter, keyboard/display controller, DMA controller, Interrupt controller etc. Familiarization with microprocessor development systems (MDS). Bus standards, IEEE 488, VME, MULTIBUS, SCSI, ISA/EISA, PCI, AGP. Selected peripheral devices and their characteristics. Peripheral controller chips, Microcontrollers.

Selected applications and design problems.

Texts:

1. R. S. Gaonkar, *Microprocessor Architecture Programming and Applications*, 2nd Ed, New Age International Publishers, 1995.

2. B. B. Brey, *The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III and Pentium IV: Architecture, Programming and Interface*, 6th Ed, Prentice Hall, 2003.

3. *MC68030 User Manual*, 4th Ed, Prentice Hall, 1995. (Downloadable from http://www.mot.com/SPS/HPESD/prod/docframe/MC68030.html)

References:

1. *Embedded UP: Intel386[TM] processors, Intel 376 processors and peripherals, 80186/80188 family*, Intel Corporation, 1995.

2. B. B. Brey, *Microprocessors and Peripherals: Hardware Software Interfacing and Applications*, Prentice Hall, 1996.

3. J. D. Giacomo, *Digital Bus Handbook,* McGraw Hill, 1990.

4. W A Triebel, *The 80386, 80486, & Pentium Processor: Hardware, Software and Interfacing*, Prentice Hall, 1998.

5. L. F. Doyle, *Computer Peripherals*, 2nd Ed, Prentice Hall, 1999.

6. J. B. Peatman, *Design with Microcontrollers,* McGraw Hill, 1988.

7. W. C. Wray, J. D. Greenfield and R. Bannatyne, *Using Microprocessors and Microcontrollers: The Motorola Family,* 4th Ed, Prentice Hall, 1999.

CS 422 Peripherals and Interfacing Laboratory (0 1 3 5)

Prerequisites: CS222, CS223

Familiarization with 8/16 bit microprocessors kits, writing simple programs. Assignments relating to interfacing. Design a standalone system. System development: case studies in instrumentation, process control systems etc. using PC based add-on cards. Use of a hardware description language such as VHDL, Verilog to describe & simulate the hardware of selected problems targeted to FPGA.

CS 498 Project (0 0 10 10)

Prerequisites: 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.

Computer Science and Engineering Departmental Elective Courses

CS461 **Artificial Intelligence** **3-0-0-6**

Prerequisites: CS201

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

Texts:

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

References:

1. E. Rich and K. Knight, Artificial Intelligence, McGraw Hill, 1991.

2. P. H. Winston and B. K. P. Horn, Lisp, 3rd Ed, Addison-Wesley, 1989.

3. P. Norvig, Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp, Morgan Kauffman, 1991.

4. I. Bratko, Prolog Programming for Artificial Intelligence, 3rd Ed, Addison-Wesley, 2001.

CS443 **Distributed Systems** **3-0-0-6**

Prerequisites: CS341

Introduction to distributed computing models. Issues in distribution of data and control: Clock synchronization, agreement,

deadlock detection, termination detection etc. Distributed file servers: Concurrency control and recovery, resiliency etc. Distributed programming environments: Communication primitives, selected case studies.

(Note: Some topics may be added/deleted to suit specific offerings of the course)

Texts:

1. G. F. Coulouris, J. Dollimore and T. Kindberg, Distributed Systems: Concepts and Design, 4th Ed, Addison-Wesley, 2005.

References:

1. S. Mullender (Ed), Distributed Systems, 2nd Ed, Addison-Wesley, 1994.

2. M. Singhal and N. Shivratri, Advanced Concepts in Operating Systems, McGraw Hill, 1994.

3. Selected research papers.

CS441 **Topics in Databases** **3-0-0-6**

Prerequisite: CS344 Databases

Database Computation Models: Page and Object Models

Correctness for page model: Serializability - review of the basic theory, view serializability, conflict serializability, multiversion serializability.

Concurrency control algorithms for page model: Locking schedulers:Two phase locking & variants, Nonlocking schedulers: Timestamp and optimistic methods, Multiversion Concurrency Control Protocols

Page model crash and recovery: Expanded schedules, correctness criteria for page model, sufficient syntactic conditions for page model, handling aborts, crash recovery notion of correctness, redo winner and history algorithms - checkpoints, log truncation, transaction abort, rollbacks

Correctness notion for object model: Conflict serializability for Flat Object Transactions, Tree Reducibility, Sufficient Conditions for Tree Reducibility

Concurrency Control Algorithms for objects model: Locking for Flat Object Transactions, Layered Locking, Locking on General Transaction Forests, Hybrid Algorithms

Object model crash and recovery: Correctness criteria for the object model, simple redo-history algorithm, enhanced redo-history algorithm, complete redo-history algorithm for two-layered systems and for General Object Model Executions

Concurrency control and recovery in distributed databases: Concurrency Control in Homogeneous Federations, serializability in heterogeneous federations, achieving global serializability through local Guarantees, distributed recovery: two and three-phase commit protocols

Concurrency control paradigms in parallel programming: Linearizablity, sequential consistency, global atomicity etc

Resurgence of Transactions: Software and hardware transactional memory

Texts:

1.Gerhard Weikum and Gottfried Vossen, Transactional Information Systems: Theory, Algorithms and the Practice of Concurrency Control and Recovery, Morgan-Kaufmann Publishers, San Francisco, CA, 2002.

References:

1.Philip A. Bernstein, Vassos Hadzilacos, and Nathan Goodman, Concurrency Control and Recovery in Database Systems, Addison-Wesley, Reading, MA, 1987. (Available for free download at http://research.microsoft.com/en-us/people/philbe/ccontrol.aspx)

2.Philip A. Bernstein and Eric Newcomer, Principles of Transaction Processing, Morgan Kaufmann, 1997.

3.Ahmed Elmagarmid (Ed.), Database Transaction Models for Advanced Applications. Morgan Kaufmann, 1992.

4.Maurice Herlihy and Nir Shavit, The Art of Multiprocessor Programming, Morgan Kaufmann, 2008.

B.Tech. in Electrical Engineering

Sl. No.	Sem	Subject Code	Name of the subject	L	T	P	C
Core Courses							
1	VII	EE400	Summer Training	0	0	0	2
2	VII	EE480	Electrical Power System Operation and Control	3	0	0	6
3	VII	EE481	Power Electronics and Drives	3	0	0	6
4	VII	EE482	Advanced Electrical Engineering Laboratory	0	0	3	3
5	VII	EE499A	Project	0	0	10	10
Departmental Elective Courses							
6	VII	EE4xx	Departmental Elective-I	3	0	0	6
7	VII	EE4xx	Departmental Elective-II	3	0	0	6
Open Elective Courses							
8	VII	XX4xx	Open Elective - I	3	0	0	6
			Total	**15**	**0**	**13**	**45**

List of Departmental Elective Courses for Electrical Engineering:

Sl. No.	Sem	Subject Code	Name of the Subject	L	T	P	C
1	VII	EE430	Fiber Optic Transmission Systems and Networks	3	0	0	6
2	VII	EE440	Microwave Engineering	3	0	0	6
3	VII	EE490	Image Processing	3	0	0	6

EE-400 **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.

EE480 **Electrical Power System Operation and Control** **(3-0-0-6)**

Power system analysis: modeling of power system components - integrated operation of power systems, load flow studies, economic load dispatch, load frequency control, automatic generation control (AGC), power system stability; Power system protection: Symmetrical components, fault analysis, switchgear, fuses, circuit breakers and relays. Economics of power supply systems: Economic choice of conductor size and voltage level, maximum demand and diversity factor, tariffs, power factor correction; Introduction to high voltage DC transmission (HVDC), flexible AC transmission system (FACTS), supervisory control and data acquisition (SCADA).

Texts:

1. D. P. Kothari and I. J. Nagrath, *Modern Power System Analysis*, McGraw-Hill, 2006.

2. P. Kundur, *Power System Stability and Control*, McGraw-Hill, 1995.

References:

1. Narain G. Hingorani and Laszlo Gyugyi, *Understanding FACTS*, Wiley-IEEE Press, 1999.

2. Jos Arrillaga, *High voltage direct current transmission*, IEE Power Engineering Series, 2/e, 1998.

3. A. J. Wood and B. F. Wollenberg, *Power Generation Operation and Control*, John Wiley and Sons, 2/e, 1996.

4. A. Wright and C. Christopoulos, *Electrical Power system protection*, Chapman & Hall, 1993

EE481 Power Electronics and Drives (3 0 0 6)

Power Semiconductor Devices: Diode, BJT, MOSFET, SCR, Triac, GTO, IGBT, MCT and their V-I characteristics, ratings, driver circuits, protection and cooling; AC-DC Converters (Rectifiers): Diode rectifier, thyristor based rectifier, effect of source inductance, single/three phase rectifiers, semi/full rectifiers, power factor, harmonics; DC-AC Converters (Inverters): Concept of switched mode inverters, PWM switching, voltage and frequency control of single/ three phase inverters, harmonics reduction, other switching schemes - square wave pulse switching, programmed harmonic elimination switching, current regulated modulation switching - tolerance band control, fixed frequency control; voltage source inverter (VSI), current source inverter (CSI); DC-DC Converters (Chopper): Principle; buck, boost and buck-boost converters; AC Voltage Controllers: Principle of ON-OFF control and phase control, single/three phase controllers, PWM AC voltage controller, cycloconverters; Electric drives: introduction and classification. DC motor drives: speed-torque characteristics of shunt, series, PMDC motors; dynamic models; speed and position control methods; AC motor drives: d-q model of induction motor; constant flux speed control structure; vector control model; vector control structure.

Texts:

1. N. Mohan: *Power Electronics- Converters, Applications and Design*, 3/e, John Wiley & Sons, 2003.

2. G. K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, 2003.

References:

1. Muhammad Rashid, *Power Electronics- Circuits, Devices and Applications*, 3/e, Prentice Hall, 2004.

2. B. K. Bose, *Modern Power Electronics and AC Drives*, Pearson Education, 2003.

3. Andrzej M. Trzynadlowski, *Introduction to Modern Power Electronics*, John Wiley & Sons, 1998.

4. Muhammad Rashid, *Power Electronics Handbook*, Academic Press-Elsevier, 2001

EE482 **Advanced Electrical Engineering Laboratory** **(0 0 3 3)**

Reactive power compensation, synchronization of alternators, load angle characteristics of transmission line, ABCD parameters of transmission lines, fault analysis based on over-current and differential relays, design of simple inverters and voltage controllers, speed control of electric drives.

Text/References:

1. C. S. Indulkar, *Laboratory Experiments in Electrical Power Engineering*, Khanna Publishers, 2003.
2. G. K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, 2003.
3. S. N. Singh: *Electric Power Generation, Transmission and Distribution*, Prentice-Hall, 2007.
4. R. K. Rajput, *Electrical Machines*, Laxmi Publications (P) Ltd, 3/e, 2003.
5. P. Kundur, *Power System Stability and Control*, McGraw-Hill, 1995

EE499A **Project** **(0 0 10 10)**

Electrical Engineering Departmental Elective Courses

EE430 **Fiber Optic Transmission Systems and Networks** **3-0-0-6**

Introduction to optical fiber communications. Optical Fibers: Ray and Mode theories, Multimode and Single-mode fibers, Fiber Loss, Dispersions, and Fiber manufacturing. Power coupling: splices, connectors, coupler. Optical transmitters: Light Emitting diode and Laser diodes, Laser modes. Optical Receivers: PIN and APD. Optical Amplifier. Noises and Sensitivity. System Performance: Link analyses. Multiplexing schemes: WDM systems. Introduction to optical network. Circuit switched paradigm, Packet switched paradigm. Client layer: IP, MPLS. WDM network constructions: Broadcast-and-Select WDM network, Wavelength-Routed Optical Network. Formulation of network optimization problem, Heuristic solution. WDM network elements: Optical line terminals, Optical add/drop multiplexers, Optical crossconnects. Survivability in WDM networks, 1+1, 1:1, 1: N protection, Dynamic Restoration. Overview of optical Packet Switching. Overview of Optical Access Networks, Passive Optical Network standards.

Text Book:

1. Gerd Keiser, *Optical Fiber Communications*, 4th Ed, McGrawHill, 2010.
2. Joseph C. Palais, *Fiber Optic Communications*, 5th Ed, Pearson, 2009.
3. Govind Agrawal, *Fiber-Optic Communication Systems*, 3rd Ed, Wiley.
4. Rajiv Ramaswami, Kumar N. Sivarajan and Galen H. Sasaki, *Optical Networks; A Practical Perspective, 3rd Ed, Elsevier, 2010.*

Reference Book:

1. Amnon Yariv, Pochi Yeh, *Photonics: Optical Electronics in modern communications*, 6th Ed, Oxford.
2. John M. Senior, *Optical Fiber Communications Principles and Practice*, 3rd Ed, Pearson.
3. Biswanath Mukherjee, *Optical WDM Networks*, Springer, 2006.
4. C. Siva Ram Murthy, *WDM Optical Networks: Concepts, Design and Algorithms,* PHI Learning, 2001.
5. Jun Zheng, Hussein T. Mouftah, *Optical WDM Networks: Concepts and Design Principles,* Wiley-interscience, 2004.

EE440 **Microwave Engineering** **3-0-0-6**

Transmission lines and waveguides: Distributed elements concept, Telegrapher's equations, Lossless and lossy lines, Line impedance and junction, Smith chart, TEM, TE and TM Waves, Coaxial cable, Rectangular and circular waveguides. Narrowband and broadband impedance matching: L-section impedance matching, single and double stub matching, Quarter wave transformer, Theory of small reflections, Multi section matching transformer, Tapered lines. Microwave networks: N-port microwave networks, Impedance, admittance, transmission and scattering matrix representations, Reciprocal and lossless networks, Network matrices transformations, Equivalent circuit extraction. Microwave passive circuits: RLC, microstrip and waveguide cavity resonators; Periodic structures and microwave filters; Hybrid junctions, directional couplers and power dividers; Ferrite devices and circulators. Microwave integrated circuits: Planar transmission lines, characteristics of microwave integrated circuits; design of single stage amplifier and oscillator using transistor; PIN diode based control circuits. Microwave tubes: Limitations of conventional tubes in the microwave frequency ranges, Klystron amplifier, Reflex klystron oscillator, Magnetrons, Traveling wave tubes. Microwave solid-state devices: Characteristics of microwave bipolar transistors and FET, Transferred electron devices, avalanche diode oscillators. Printed microstrip antennas: Basic characteristics, types and feeding methods of microstrip antennas, analysis of rectangular microstrip antennas using simplified models.

Texts:

1. D. M. Pozar, *Microwave Engineering*, 3/e, John Wiley & Sons Inc, 2004.
2. R. E. Collin, *Foundations for Microwave Engineering*, 2/e, Wiley-IEEE Press, 2000.
3. A. Das and S. K. Das, *Microwave Engineering*, 1/e, Tata McGraw-Hill, 2005.

References:

1. G. Kumar and K. P. Ray, *Broadband Microstrip Antennas*, 1/e, Artech House, 2002.
2. R. C. Booton, *Computational methods for Electromagnetics and Microwaves*, 1/e, Wiley, 1992.
3. G. Gonzalez, Microwave *Transistor Amplifiers: Analysis and Design*, 2/e, Prentice Hall of India, 2007.
4. S. M. Liao, *Microwave devices and Circuits*,3/e, Prentice Hall of India, 2004.
5. P. A. Rizzi, *Microwave Engineering Passive Circuits*, 1/e, Pearson, 1998.

EE490 **Image Processing** **3-0-0-6**

Human visual system and image perception; monochrome and colour vision models; image acquisition and display: video I/O devices; standard video formats; image digitization, display and storage; 2-D signals and systems; image transforms- 2D DFT, DCT, KLT, Harr transform and discrete wavelet transform; image enhancement: histogram processing, spatial-filtering, frequency-domain filtering; image restoration: linear degradation model, inverse filtering, Wiener filtering; image compression: lossy and lossless compression, entropy coding, transform coding, subband coding, image compression standards, video compression- motion compensation, video compression standards; image analysis: edge and line detection, segmentation, feature extraction, classification; image texture analysis; morphological image processing: binary

morphology- erosion, dilation, opening and closing operations, applications; basic gray-scale morphology operations; colour image processing: colour models and colour image processing Experiments are based on MATLAB implementation of algorithms covered in the course.

Texts/References:

1. A. K. Jain, *Fundamentals of Digital Image processing*, Pearson Education, 1989.

2. R. C. Gonzalez and R. E. Woods: *Digital Image Processing*, Pearson Education, 2001

3. R. C. Gonzalez , R. E. Woods and S. L. Eddins: *Digital Image Processing using MATLAB*, Pearson Education, 2004.

4. G. A. Baxes: *Digital Image Processing*; John Wiley, 1994

5. R.J. Schalkoff: *Digital Image Processing and Computer Vision*; John Wiley, 1989.

6. Sid Ahmed: *Image Processing*; McGraw-Hill, 1994.

7. S.J. Solari: *Digital Video and Audio Compression*; McGraw-Hill, 1996.

B.Tech. in Mechanical Engineering

Sl. No.	Sem	Subject Code	Name of the subject	L	T	P	C
Core Courses							
1	VII	ME400	Summer Training	0	0	0	2
2	VII	ME401	Industrial Engineering and Operations Research	3	1	0	8
3	VII	ME411	Mechanical Engineering Laboratory- IV	0	0	4	4
4	VII	ME498	Project-I	0	0	8	8
Departmental Elective Courses							
5	VII	MExxx	Departmental Elective-I	3	0	0	6
6	VII	MExxx	Departmental Elective-II	3	0	0	6
Open Elective Courses							
7	VII	XX4xx	Open Elective - I	3	0	0	6
			Total	**12**	**1**	**12**	**40**

List of Departmental Elective Courses for Mechanical Engineering:

Sl. No.	Sem	Subject Code	Name of the Subject	L	T	P	C
1	VII	ME441	Computational Fluid Dynamics	3	0	0	6
2	VII	ME443	Dynamics of Structural Members	3	0	0	6
3	VII	ME445	**Finite Element Method**	3	0	0	6
4	VII	ME447	Laser Material Processing	3	0	0	6
5	VII	ME449	Refrigeration and Air Conditioning	3	0	0	6
6	VII	ME461	Robotics and Robot Applications	3	0	0	6

ME-400 **Summer Training** **(0 0 0 2)**
Prerequisites: 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.

ME-401 **Industrial Engineering and Operations Research** **(3 1 0 8)**

Prerequisites: 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**.**

Texts:

1. S L Narasimhan, D W McLeavey, P J Billington, *Production, Planning and Inventory Control*, Prentice Hall,

1997.

2. J L Riggs, *Production Systems: Planning, Analysis and Control*, Wiley, 3rd ed., 1981.

3. A Muhlemann, J Oakland and K Lockyer, *Productions and Operations Management*, Macmillan, 1992.

4. H A Taha, *Operations Research - An Introduction*, Prentice Hall of India, 1997.

5. J K Sharma, *Operations Research*, Macmillan, 1997.

ME-411 Mechanical Engineering Laboratory – IV (0 0 4 4)

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.

ME-498 Project – I (0 0 8 8)

Mechanical Engineering Departmental Elective Courses

ME441 **Computational Fluid Dynamics** **(3 0 0 6)**

Prerequisites: MA 201, ME 204, ME 206

(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.

Text Book/ Reference Books:

1. J. D. Anderson, *Computational Fluid Dynamics*, McGraw-Hill Inc., 1995.
2. S. V. Patankar, *Numerical Heat Transfer and Fluid Flow*, Hemisphere Pub, 1980.
3. D. A. Anderson, J.C. Tannehill and R.H. Pletcher, *Computational Fluid Mechanics and Heat Transfer*, Hemisphere Pub, 1984
4. M. Peric and J. H. Ferziger, *Computational Methods for Fluid Dynamics*, Springer, 2001.
5. H.K. Versteeg and W. Malalaskera, *An Introduction to Computational Fluid Dynamics*, Dorling Kindersley (india) Pvt Ltd,2008.
6. C. Hirsch, *Numerical Computation of Internal and External Flows,* Butterworth-heinemann, 2007.
7. P.S. Ghoshdastidar, *Computer Simulation of Flow and Heat Transfer*, Tata-McGrawhill, 1998.

ME443 **Dynamics of Structural Members** **(3 0 0 6)**

Prerequisites: Dynamics of Machinery (ME 308); Control Systems (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 and references:

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

ME 445 Finite Element Method (3 0 0 6)

Prerequisite: 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/reference:

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

ME447 **Laser Material Processing** **(3 0 0 6)**

Prerequisites: 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.

Text/References:

1. W. M. Steen and J. Mazumder, *Laser Material Processing*, 4'th Edition, Springer, 2010.

2. E. Kannatey-Asibu, *Principles of Laser Materials Processing*, , Wiley, 2009.

3. N. B. Dahotre and S P Harimkar, *Laser Fabrication and Machining of Materials*, Springer, 2008.

4. John C. Ion, *Laser Processing of Engineering Materials*, Elsevier, 2005.

5. J. F. Ready (Editor), *LIA Handbook of Laser Materials Processing*, Springer, 2001.

6. M. von Allmen and A . Blatter, *Laser-Beam Interactions with Materials*, 2'nd Edition, Springer, 1998.

ME-449 **Refrigeration and Air conditioning** **(3 0 0 6)**

Prerequisites: 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:

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

ME 461 Robotics and Robot applications (3 0 0 6)

Prerequisites: 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;

Reference Books:

1. M.P Groover, M. Weiss, R. N. Nagel and N. G. Odrey, *Industrial Robotics-Technology, programming and applications*, McGraw-Hill Book and Company, 1986.

2. S.K. Saha, *Introduction to Robotics*, Tata McGraw-Hill Publishing Company Ltd, 2008

3. S. B. Niku, *Introduction to Robotics- analysis systems*, applications, Pearson Education, 2001

4. Pires, *Industrial Robot Programming - building application for the factories of the future*, Springer, 2007

5. Peters, *Image Guided Interventions – Technology and applications*, Springer, 2008

Open Elective – I courses for B.Tech Fourth Year Odd Semester

List of Open Elective - I Courses:							
Sl. No.	**Sem**	**Subject Code**	**Name of the Subject**	**L**	**T**	**P**	**C**
1	VII	CS401	Foundations of Computer Science	3	0	0	6
2	VII	MA410	Graphs, Groups and Network	3	0	0	6
3	VII	ME481	Introduction to Biomechanics	3	0	0	6
4	VII	PH401	Introduction to Nanomaterials	3	0	0	6
5	VII	PH402	Solid State Devices	3	0	0	6

CS401 **Foundations of Computer Science** **(3-0-0-6)**

Prerequisites: 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:

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

References:

1. Lecture notes and handouts will be provided

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:

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

ME- 481 Introduction to Biomechanics (3-0-0- 6)

Prerequisites: 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:

1. Jay D. Humphrey and Sherry DeLange, *An Introduction to Biomechanics: Solids and Fluids, Analysis and Design*, Springer; 1st Edition, 2004.
2. Roger Bartlett, *Introduction to Sports Biomechanics: Analysing Human Movement Patterns*, Routledge; 2nd Edition, 2007.
3. Stephen C. Cowin and Jay D. Humphrey, Edt. *Cardiovascular Soft Tissue Mechanics*, Kluwer Academic Publishers, 2000.
4. Walter D. Pilkey, Dmitry V. Balandin and Nikolai N. Bolotnik, *Injury Biomechanics and Control: Optimal Protection from Impact,* 1st Edition. Wiley 2009.
5. Don B. Chaffin, Gunnar B. J. Andersson and Bernard J. Martin, *Occupational Biomechanics*, Wiley-Interscience 3rd Edition, 1999.
6. John G. Webster, *Medical Instrumentation: Application and Design*, Wiley; 3rd Edition, 1997.

PH401 Introduction to Nanomaterials 3-0-0-6

Prerequisites: 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:

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

References:

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

PH402 **Solid State Devices** **3-0-0-6**

Prerequisites: 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:

1. Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, 2nd Edition, Rainer Waser (ed.), Wiley – VCH Publishers, 2003.

2. Physics of Semiconductor Devices, S. M. Sze, John Wiley & Sons, 2nd edition, 1981.

3. Microwave Devices & Circuits, Sammuel Y. Liao, 3rd Edition, Pearson Education, 2003.

4. Ferroelectric Devices, K. Uchino, 2nd edition, CRC Press, 2009.

5. Semiconductor LASERS I: Fundamentals, E. Kapon, Academic Press (Indian edition), 2006.

6. Optical Materials, John H. Simmons and Kelly S. Potter, Academic Press (Indian edition), 2006.

7. Electronic Properties of Materials, Rolf E. Hummel, Springer (3rd edition)

8. Energy Storage, R. A. Huggins, Springer, 2010.

References:

1. Batteries for Electric Vehicles, R. Woods, D. A. J. Rand & R. M. Dell, Research Studies Press Pvt. Ltd., 1998.

2. Fuel Cell Engines, Matthew M. Mench, John Wiley & Sons, 2008..

3. Fuel Cell Technology, Nigel Sammes (ed.), 1st edition, Springer, 2006.

4. Electrochemical Supercapacitors: Fundamentals & Technological Applications, B. E. Conway, Academic Press, 1998.

5. Clean Energy, R. M. Dell & D. A. J. Rand, Royal Society Publications, 2004

6. Hydrogen Energy: Challenges & Prospects, R. M. Dell & D. A. J. Rand, Royal Society Publications, 2008.

7. Fundamentals of Photovoltaic Modules and their Applications, G. N. Tiwari, S. Dubey & Julian C. R. Hunt, RSC Energy Series, 2009.