INDIAN INSTITUTE OF TECHNOLOGY PATNA

Programme: Bachelor of Technology in Computer Science & 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
CS 203	Discrete Mathematics	3-0-0-6
CS 221	Digital Design	3-0-0-6
EC 220	Signals, Systems and Networks	3-1-0-8
	Total L-T-P-C	**18-2-3-43**

Fourth Semester

HS2xx	HSS Elective	3-0-0-6
XX2xx	Science Elective	3-0-0-6
CS 204	Algorithms	3-0-0-6
CS 222	Computer Organization and Architecture	3-0-0-6
CS 223	Hardware Laboratory	0-0-3-3
CS 241	Software Engineering	2-0-3-7
CS 242	Systems Programming Laboratory	0-1-3-5

MA 225	Probability Theory and Random Processes	3-1-0-8
	Total L-T-P-C	**17-2-9-47**

Fifth Semester

CS 301	Formal Language and Automata	3-0-0-6
CS 331	Programming Language	3-0-2-8
CS 341	Operating Systems	3-0-0-6
CS 342	Operating Systems Laboratory	0-1-3-5
CS 343	Data Communications	3-0-0-6
CS 344	Databases	3-0-0-6
CS 345	Databases Laboratory	0-1-3-5
	Total L-T-P-C	**15-2-8-42**

Sixth Semester

HS3xx	HSS Elective	3-0-0-6
CS 302	Theory of Computation	3-0-0-6
CS 346	Compilers	3-0-0-6
CS 347	Compliers Laboratory	0-0-3-3
CS 348	Computer Networks	3-0-2-8
CS 362	Computer Graphics	3-0-2-8
CS 399	Seminar	0-0-3-3
	Total L-T-P-C	**15-0-10-40**

Seventh Semester

XX4xx	Open Elective - I	3-0-0-6
CS 498	Project-I	0-0-10-10
CS xxx	Departmental Elective – I	3-0-0-6
CS xxx	Departmental Elective - II	3-0-0-6
CS 421	Computer Peripherals and Interfacing	3-0-0-6
CS 422	Peripherals and Interfacing Lab	0-1-3-5
CS400	Summer Training	0-0-0-2
	Total L-T-P-C	**12-1-13-41**

Eighth Semester

XX4xx	Open Elective - II	3-0-0-6
HS4xx	HSS Elective	3-0-0-6
CS 499	Project – II	0-0-16-16
CS xxx	Departmental Elective - III	3-0-0-6
CS 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:	**119-14-78-344**

    * 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.

Courses

B.Tech Courses

CS101 Introduction to Computing

CS101	Introduction to Computing	3-0-0-6	Pre-requisites: Nil

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

Program development: programming tools, testing and debugging.

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

References:

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

CS110 Computing Laboratory

CS110	Computing Laboratory	0-0-3-3	Pre-requisites: Nil

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

References:

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

CS201 OOP and Data Structures

CS201	OOP and Data Structures	3-0-3-9	Pre-requisites: CS101

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

Texts:

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

References:

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

CS203 Discrete Mathematics

CS203	Discrete Mathematics	3-0-0-6	Pre-requisites: Nil

Set theory: sets, functions, relations, partial orders, lattices. Logic: propositional logic (formulae, truth tables, proof systems, soundness and completeness of proof systems), predicate logic (formulae, interpretations, proof systems, soundness and completeness of proof systems). Combinatorics: permutations, combinations, partitions, Stirling

numbers. Recurrences, summations, generating functions, asymptotics. Graph Theory: paths, connectivity, subgraphs, isomorphic and homeomorphic graphs, trees, complete graphs, bipartite graphs, matchings, colourability, planarity, digraphs. Algebraic Structures: semigroups, groups, subgroups, homomorphisms, rings, integral domains, fields.

Texts:

- J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 199
  References:

- C. L. Liu, Elements of Discrete Mathematics, 2nd Ed, Tata McGraw-Hill, 2000.
- R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed, Addison-Wesley, 1994.
- N. Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 1974.
- S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed, Tata McGraw-Hill, 1999.

CS221 Digital Design

CS221	Digital Design	3-0-0-6	Pre-requisites: Nil

Number Systems: representations of numbers (binary, octal, decimal, and hexadecimal), arithmetics of signed and unsigned numbers. Boolean Algebra and logic gates: gate level minimization of Boolean functions. Combinational logic circuits: design and analysis, some standard combinational circuits (encoders, decoders, multiplexers). Sample and hold Circuits, Analog-to-Digital Converter, Digital-to-Analog Converter. Synchronous sequential logic circuits: design and analysis; flip-flops, registers, counters; finite state model: state tables and state diagram, state minimization. Asynchronous sequential logic circuits: design and analysis; incompletely specified machines; reduction of states and flow tables; race free state assignments. Programmable logic devices: memory, PLA, PAL. Representation and synthesis using ASM charts.

Texts:

- M. M. Mano, Digital Design, 3rd Ed, Pearson Education Asia, 2002.

References:

- S. Brown and Z. Vranesic, Fundamentals of Digital Logic - With Verilog Design, Tata McGraw-Hill, 2002.
- S. Brown and Z. Vranesic, Fundamentals of Digital Logic - With VHDL Design, Tata McGraw-Hill, 2002
- J. P Uyemura, A First Course in Digital System Design - An Integrated Approach, Vikas Publishing House, 2001.
- Z. Kohavi, Switching and Finite Automata Theory, 2nd Ed, Tata McGraw-Hill, 1995.

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

CS204 Algorithms

CS204	Algorithms	3-0-0-6	Pre-requisites: CS201, CS203

Models of Computation: Turing machines and random access machines, space and time complexity measures, lower and upper bounds. Design and analysis techniques: the greedy method, divide-and-conquer, dynamic programming, backtracking, branch and bound, amortized analysis. Priority Queues: lists, heaps, binomial heaps, Fibonacci heaps. Sorting and order statistics: sorting algorithms (insertion-sort, bubble-sort, shell-sort, quicksort, merge-sort, heapsort and external-sort) and their analyses, selection. Graph Algorithms: connectivity, biconnectivity, topological sort, shortest paths, minimum spanning trees, maximum flow. Advanced topics: the disjoint set union problem; string matching; NP-completeness; geometric, approximation, parallel, and randomized algorithms.

Texts:

- T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, MIT Press, 2001.

References:

- A. Aho, J. E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley, 1974.
- S. Sahni, Data Structures, Algorithms and Applications in C++, McGraw-Hill, 2001.
- M. T. Goodrich and R. Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, John Wiley & Sons, 2001.

CS222 Computer Organization and Architecture

CS222	Computer Organization and Architecture	3-0-0-6	Pre-requisites: CS221

Memory organization: hierarchical memory systems, cache memories, cache coherence, virtual memory. System buses: interconnection structures and bus interconnection. Arithmetic Logic Unit. Study of an existing CPU: architecture, instruction set and the addressing modes supported; assembly language programming. Control unit Design: instruction interpretation, hardwired and microprogrammed methods of design. RISC and CISC paradigms. I/O Transfer techniques: programmed, interrupt-driven and DMA; I/O processors and channels, mapping of I/O addresses. Advanced architectures: parallel and pipelined systems, dataflow, hypercubes, superscalar processors.

Texts:

- A. Tenenbaum, Structured Computer Organization, 4th Ed, Prentice-Hall of India, 1999.
- W. Stallings, Computer Organization and Architecture: Designing for Performance, 6th Ed, Prentice Hall, 2005.

References:

- J. Hennessy and D. Patterson, Computer Architecture A Quantitative Approach, 3rd Ed, Morgan Kaufmann, 2002.

CS223 Hardware Laboratory

CS223	Hardware Laboratory	0-0-3-3	Pre-requisites: CS221

Design of synchronous and asynchronous sequential circuits. Digital system design using RTL level functional blocks. Design of various controllers using hardwired and/or microprogrammed techniques. Design of a CPU using SSI/MSI/LSI level components: choice of word size, instruction format, I/O and memory interface, datapath, control unit. Introduction to hardware description languages such as VHDL, Verilog, etc.

References:

- Analog and digital data manuals.

CS241 Software Engineering

CS241	Software Engineering	2-0-3-7	Pre-requisites: CS201

The software life cycle, nature and qualities of software, software engineering principles. Software project management: planning, scheduling, monitoring, control, risk management. Requirements specification: specification styles (informal, formal), operational and descriptive specifications. Software Design: function-oriented and object-oriented approaches; architectural, component-level and user-Interfaces design; structured programming and implementation. Verification: testing (strategies and techniques), formal methods, validation. Advanced topics: maintenance, reengineering, product metrics. Software Engineering tools and environments. Use of some software engineering packages in laboratory assignments.

Texts:

- R. S. Pressman, Software Engineering: A Practioner's Approach, 5th Ed, McGraw-Hill, 2001.

References:

- I. Sommerville, Software Engineering, 7th Ed, Addison-Wesley, 2005.
- C. Ghezzi, M. Jazayeri and D. Mandrioli, Fundamentals of Software Engineering, 2nd Ed, Prentice Hall of India, 2003.

CS242 Systems Programming Laboratory

CS242	Systems Programming Laboratory	0-1-3-5	Pre-requisites: CS201

Linux administration: basic utilities, make, logging, backup, authentication; PERL programming; Unix system calls and shell programming; electronic mail administration; assemblers, linkers and loaders; assembly language programming; introduction to LaTeX.

References:

- E. Nemeth, G. Snyder and T. R. Hein, Linux Administration Handbook, Prentice Hall PTR, 2002.
- L. Wall, T. Christainsen and J. Orwant, Programming PERL, 3rd Ed, O'Reilly, 1999.
- B. Kauler, Windows assembly language & Systems Programming: 16- And 32-Bit Low-Level Programming for the PC and Windows, 2nd Ed, CMP Books; August 1997.
- D. Curry, UNIX Systems Programming for SVR4, O'Reilly, 1996.
- S. Kochan and P. Wood, Unix Shell programming, 3rd Ed, SAMS, 2003.
- S. Das, Unix System V.4 Concepts and Applications, 3rd Ed, Tata Mcgraw-Hill, 2003.
- Linux Manuals.
- A. Rubini and J. Corbet, Linux Device Drivers, 2nd Ed, O'Reilly, 2001.

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: (n), $\mu(n)$, $d(n)$, (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	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 Eelctives

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 CULTURES	3-0-0-6	Pre-requisites:Nil

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

CS301 Formal Language and Automata

CS301	Formal Language and Automata	3-0-0-6	Pre-requisites: CS203

Basic concepts: alphabets, languages, and grammars. Regular Languages: regular expressions and algebraic laws thereof; deterministic and nondeterministic finite automata (DFAs and NFAs): equivalence of DFAs and NFAs, minimization of DFAs, Myhill-Nerode theorem; regular grammars; closure properties of regular languages; Pumping lemma; decidable properties of regular languages. Context free languages: context free grammars (CFGs): derivations, derivation trees, ambiguous grammars, inherently ambiguous languages, normal forms of CFGs: Chomsky Normal Form and Greibach Normal Form; pushdown automata (PDAs): deterministic and nondeterministic PDAs (DPDAs and NPDAs); deterministic CFLs, LL (k) and LALR grammars; closure properties of CFLs; Pumping lemma and Ogden's Lemma; decidable properties of CFLs. Context sensitive languages: context sensitive grammars; linear bounded automata. Recursively enumerable languages: unrestricted grammars; Turing machines: variants and equivalence thereof; random access machine and its equivalence with Turing machine.

Texts:

- J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, Pearson Education India, 2001.
- D. I. A. Cohen, Introduction to Computer Theory, John Wiley & Sons, 1997.

References:

- J. C. Martin, Introduction to Languages and the Theory of Computation, 3rd Ed, Tata McGraw-Hill, 2002.
- H. R. Lewis and C. H. Papadimitriou, Elements of the Theory of Computation, Prentice Hall, 1997.

CS331 Programming Language

CS331	Programming Language	3-0-2-8	Pre-requisites: CS201

Introduction to various programming paradigms and their implementation issues. Imperative programming: block structure; scoping rules; parameter passing etc. in languages like C, Pascal, Fortran. Object-oriented programming: abstraction, hiding; objects; classes; inheritance etc in languages like C++, Modula, Java. Functional programming:

functions; recursion; types; polymorphism; storage allocation etc in languages like LISP, ML, Scheme. Logic programming: Horn clauses; SLD-resolution etc in languages like Prolog. Introduction to concurrent programming: expressing parallelism; communication; synchronization etc in languages like Ada, CSP, Linda. Semantics of programming languages. (The course will include programming lab assignments in various languages.)

Texts:

- R. Sethi, Programming Languages: Concepts and Constructs, 2nd Ed, Addison-Wesley, 1996.

References:

- T. W. Pratt, M. V. Zelkowitz, Programming Languages: Design and Implementation, 4th Ed, Prentice Hall, 2001.
- R. Stansifer, The Study of Programming Languages, Prentice Hall, 1994

CS341 Operating Systems

CS341	Operating Systems	3-0-0-6	Pre-requisites: CS201, CS222

Process Management: process; thread; scheduling. Concurrency: mutual exclusion; synchronization; semaphores; deadlocks. Memory Management: allocation; protection; hardware support; paging; segmentation. Virtual Memory: demand paging; allocation; replacement; swapping; segmentation; TLBs. File Management: naming; file operations and their implementation. File systems: allocation; free space management; directory management; mounting. I/O Management: device drivers; disk scheduling; block I/O; character I/O. (Unix will be used as a running example, while examples will drawn also from DOS and NT.)

Texts:

- A. Silberschatz, P. B. Galvin and G. Gagne, Operating System Concepts, 7th Ed, John Wiley & Sons, 2004.

References:

- A. Silberschatz, P. B. Galvin and G. Gagne, Operating System Concepts with Java, 6th Ed, John Wiley & Sons, 2003.
- A. S. Tenenbaum, Modern Operating Systems, 2nd Ed, Prentice Hall of India, 2001.
- H. M. Deitel, P. J. Deitel and D. R. Choffness, Operating Systems, 3rd Ed, Prentice Hall, 2004.
- W. Stallings, Operating Systems: Internal and Design Principles, 5th Ed, Prentice Hall, 2005.
- M. J. Bach, The Design of the UNIX Operating System, Prentice Hall of India, 1994.
- M. K. McKusick et al, The Design and Implementation of the 4.4 BSD Operating System, Addison Wesley, 1996.

CS342 Operating Systems Laboratory

CS342	Operating Systems Laboratory	0-1-3-5	Pre-requisites: CS201, CS222, CS223, CS242

Programming assignments to build parts of an OS kernel. Use of a teaching package such as Nachos.

CS343 Data Communications

CS343	Data Communications	3-0-0-6	Pre-requisites: CS222

Basics of Digital Communications: signals, noise, Nyquist's rate, Fourier transforms of signals, harmonics. Baseband and broadband transmission: modulation techniques; fundamentals of modems; local loop implementation. Digital transmission of voice: PCM, ADPCM, time division multiplexing; T1, T3 formats. Fibre optics: basic principles; SONET; technologies. VSAT technology: TDMA, DAMA; point-to-point wireless communication (microwave). Local Area Networks: Ethernet (CSMA/CD operation; parameters, specifications, limitations); cabling (Ethernet, Fast-Ethernet, Gigabit Ethernet; hubs, patch panels, wiring closets); bridges; switches; virtual LANs; 100BaseT; 100BaseVGANY; gigabit Ethernet; FDDI; token ring; wireless networks; ISDN, B-ISDN.

Texts:

- W. Stallings, Data and Computer Communications, 7th Ed, Prentice Hall, 2004.

References:

- A. S. Tenenbaum, Computer Networks, 4th Ed, Prentice Hall PTR, 2003.
- B. A. Forouzan, Data Communications and Networking, 3rd Ed, McGraw Hill, 2004.
- J. F. Kurose and K. W. Ross, Computer networking: A Top-down Approach Featuring the Internet, 3rd Ed, Addison-Wesley, 2005.
- T. Ramteke, Networks, 2nd Ed, Prentice Hall, 2001.
- G. Held, Ethernet Networks: Design, Implementation, Operation, Management, 4th Ed, John Wiley & Sons, 2002.

CS344 Databases

CS344	Databases	3-0-0-6	Pre-requisites: CS201, CS203

Data models: entity-relationship, relational, network, hierarchical, and logic data models, with the emphasis on the relational model. Query languages: relational algebra, relational calculus, SQL, QBE. Theory of database design: functional dependencies; normal forms: 1NF, 2NF, 3NF, Boyce-Codd NF; decompositions; normalization; multivalued dependencies, join dependencies, 4NF, 5NF. Data storage and indexing: disks, files, file organizations, indexes; tree structured indexing (ISAM, B-trees), hash based indexing. Query processing: evaluation of relational operators, query optimization; transcation management, Concurrency control; error recovery; security. Case studies: ORACLE, Microsoft access etc. Introduction to Open Database Connectivity, Client-Server environment etc.

Texts:

- R. Ramakrishnan and J. Gehrke, Database Management Systems, 3rd Ed, McGraw Hill, 2002.

References:

- A. Silberschatz, H. F. Korth and S. Sudarshan, Database System Concepts, 4th Ed, McGraw Hill, 2001.
- T. Connolly and C. Begg, Database Systems, 3rd Ed, Pearson Education, 2002.
- R. Elmasri, S. B. Navathe and R. Sunderraman, Fundamentals of Database Systems / Oracle 9i Programming, 4th Ed, Benjamin Cummings Publishing Company, 2004.
- H. Garcia-Molina, J. D. Ullman and J. D. Widom, Database Systems: The Complete Book, Prentice Hall, 2002.
- C. J. Date, An Introduction to Database Systems, 6th Ed, Addison Wesley, 1995.
- J. Melton, Understanding the New SQL: A Complete Guide, 2nd Ed, Morgan Kaufmann Publishers, 2000.

CS345 Databases Laboratory

CS345	Databases Laboratory	0-1-3-5	Pre-requisites: CS201

Familiarization with various databases packages like Microsoft Access, ORACLE, SQL Server, DB2 etc. Client-server and 3 tier web enabled database programming. Use of Application servers. Design and implementation of a Database application using a multi-user DBMS.

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

CS302 Theory of Computation

CS302	Theory of Computation	3-0-0-6	Pre-requisites: CS203, CS301

Formal Logic: proof systems for propositional and first-order logic; consistency; completeness; compactness. Computability: primitive recursive functions; Godelization; Church's thesis. Review of models of computations, time and space bounded computations. Classes P, NP, polynomial reducibilities, NP-completeness.

Texts:

- Lewis, H.R., Papadimitriou, C.H., Elements of the Theory of Computation, Prentice-Hall of India, 1996.
- Garey, D.S., Johnson, G., Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, New York, 1979.

References:

- Hopcroft, J.D. Ullman, Introduction to Automata Theory, Languages and Computation, Addison-Wesley, 1979.
- Papadimitriou, C.H., Computational Complexity, Addison-Wesley Publishing Company, Inc., 1994.
- Balcazar, Diaz, Gubarro, Structural Complexity, Volumes I, II, Springer-Verlag, 1988.

CS346 Compilers

CS346	Compilers	3-0-0-6	Pre-requisites: CS201, CS301

Overview of different phases of a compiler : front-end; back-end. Lexical analysis: finite automata; DFA construction and minimization; automatic tools. Syntax analysis: context free grammars; top down and bottom up parsing techniques; construction of efficient parsers; syntax-directed translation; automatic tools. Semantic analysis: declaration processing; type checking; symbol tables; error recovery. Intermediate code generation: run-time environments; translation of language constructs. Code generation: Flow-graphs; register allocation; code-generation algorithms. Introduction to code optimization techniques.

Texts:

- Aho A., Sethi R., Ullman J.D., Compilers : Principles, Techniques and Tools, Addison Wesley, 1995.

References:

- Holub, A.I.,Compiler Design in C, Prentice-Hall of India, 1993.
- Tremblay, A.S., and Sorenson, P.G., The Theory and Practice of Compiler Writing, McGraw-Hill Int. Edition, 1985.
- Fischer, C.N., Le Blanc, R.J., Crafting a Compiler. Benjamin/Cummings California, 1988.

CS347 Compilers Laboratory

CS347	Compilers Laboratory	0-0-3-3	Pre-requisites: CS202

Programming assignments to build a compiler for a subset of a C-like programming language, using tools such as Lex and Yacc.

CS348 Computer Networks

CS348	Computer Networks	3-0-2-8	Pre-requisites: CS201, CS343

7 layer OSI/ISO model; evolution of computer networks. Data Link Layer: HDLC, PPP, sliding window protocols. Network Layer: IP, ICMP, X.25, Frame Relay, ATM, routing algorithms (EGP, RIP, OSPF etc.); Transport Layer: TCP, UDP, congestion control, flow control; Sockets interface, sockets programming; Application Layer: SNMP, Authentication, Encryption, electronic mail. WWW basics: http, html, CGI, Java, Firewalls.

Texts:

- Tanenbaum A.S., Computer Networks, 3rd Edition, Prentice Hall of India, 1996.

References:

- Stallings, W., Data and Computer Communications, 4/e, Prentice Hall of India,1996.
- Stevens, D.L. et al., TCP/IP Illustrated, Volumes I, II and III, Addison Wesley, 1996.

CS362 Computer Graphics

CS362	Computer Graphics	3-0-2-8	Pre-requisites: CS204

Introduction: organization of an interactive graphics system. Scan conversion, filling, clipping, antialiasing, geometrical transformations, viewing, hidden line and hidden surface removal, representation of curves and surfaces, solid modeling, illumination and shading. Graphical user interfaces and Interactive input methods. The laboratory work will involve programming with standard graphics libraries like OpenGL.

Texts:

- J. D. Foley, A. van Dam, S. Feiner, and J. F. Hughes, Computer Graphics: Principles and Practice, 2nd Ed, Addison-Wesley, 1996.

References:

- D. Hearn and M. P. Baker, Computer Graphics with OpenGL, 3rd Ed, Prentice Hall, 2004.
- M. Woo, J. Neider, T. Davis and D. Shreiner, OpenGL Programming Guide: The Official Guide to

Learning Open GL, 4th Ed, Addison Wesley, 2004.

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

CS400 Summer Training

CS400	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.

CS421 Computer Peripherals and Interfacing

CS421	Computer Peripherals and Interfacing	3-0-0-6	Pre-requisites: 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:

- R. S. Gaonkar, Microprocessor Architecture Programming and Applications, 2nd Ed, New Age International Publishers, 1995.
- 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..
- MC68030 User Manual, 4th Ed, Prentice Hall, 1995. (Downloadable from http://www.mot.com/SPS/HPESD/prod/docframe/MC68030.html).

References:

- Embedded UP: Intel386[TM] processors, Intel 376 processors and peripherals, 80186/80188 family, Intel Corporation, 1995.
- B. B. Brey, Microprocessors and Peripherals: Hardware Software Interfacing and Applications, Prentice Hall, 1996.
- J. D. Giacomo, Digital Bus Handbook, McGraw Hill, 1990.
- W A Triebel, The 80386, 80486, & Pentium Processor: Hardware, Software and Interfacing, Prentice Hall, 1998.
- L. F. Doyle, Computer Peripherals, 2nd Ed, Prentice Hall, 1999.
- J. B. Peatman, Design with Microcontrollers, McGraw Hill, 1988.
- W. C. Wray, J. D. Greenfield and R. Bannatyne, Using Microprocessors and Microcontrollers: The Motorola Family, 4th Ed, Prentice Hall, 1999

CS422 Peripherals and Interfacing Laboratory

CS422	Peripherals and Interfacing Laboratory	0-1-3-5	Pre-requisites: 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.

CS498 Project

CS498	Project	0-0-10-10	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.

Introduction to VLSI CAD

CS423	Introduction to VLSI CAD	3-0-0-6	Pre-requisites: Nil

Objective:

Modeling and optimization has always been a matter of great theoretical and practical interest. These techniques have found application in a variety of areas like Physics, Engineering Design, Electronic Design Automation (EDA), Bioinformatics, Operations Research, Economics and Social Sciences. The present course aims at exposing our students to some of these techniques focusing on some aspects of EDA. An important segment of EDA is Computer Aided Design (CAD) of Very Large Scale Integration (VLSI) circuits and systems. The present course aims at introducing the students to algorithms and optimization techniques employed by CAD tools for design of VLSI circuits and systems.

Course Content:

Introduction: Motivation behind CAD tools, Components on a single chip, Brief illustration of the design flow employed by VLSI CAD tools, Algorithmic background for VLSI CAD; **High Level Synthesis**: Operator DAG Formation, Scheduling, ASAP and ALAP Scheduling, Resource Constrained Scheduling, Time Constrained Scheduling,Register Minimization and Functional Unit Allocation, Binding; **Combinational Logic Synthesis**: Karnaugh Map, Quine-McClausky, Espresso; **Sequential Logic Synthesis**: State Encoding, State Assignment; **Physical Design**: Partitioning using K-L,F-M method, Placement and Floor-planning using ILP and Constraint solving methods, Horizontal and vertical constraint graphs for routing, 2-layer and 3-layer routing algorithms.

Texts:

1. "High-Level Synthesis: Introduction to Chip and System Design" by D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, Springer, 1st edition, 1992.
2. "Synthesis and Optimization of Digital Circuits" by Giovanni De Michelli, McGraw-Hill Higher Education ©1994
3. "Algorithms for VLSI Physical Design Automation" by N. A. Sherwani, Bsp Books Pvt. Ltd., 3rd edition, 2005.

Lecture notes and handouts will be provided.

CS561 Artificial Intelligence

CS561	Artificial Intelligence	3-0-0-6	Pre-requisites: 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:

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

References:

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

CS543 Distributed Systems

CS543	Distributed Systems	3-0-0-6	Pre-requisites: 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:

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

References:

- S. Mullender (Ed), Distributed Systems, 2nd Ed, Addison-Wesley, 1994.
- M. Singhal and N. Shivratri, Advanced Concepts in Operating Systems, McGraw Hill, 1994.
- Selected research papers

CS441 Topics in Databases

CS441	Topics in Databases	3-0-0-6	Pre-requisites: CS344

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:

- 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:

- 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)
- Philip A. Bernstein and Eric Newcomer, Principles of Transaction Processing, Morgan Kaufmann, 1997.
- Ahmed Elmagarmid (Ed.), Database Transaction Models for Advanced Applications. Morgan Kaufmann, 1992.
- Maurice Herlihy and Nir Shavit, The Art of Multiprocessor Programming, Morgan Kaufmann, 2008.

CS542: Software Testing

CS542	Software Testing	3-0-0-6	Pre-requisites: NIL

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	Contac
1.	**Introduction to Biological System**	
2.	**Cell, Tissues and Connective Tissues and their Phenomenological Models: Bone,**	1

	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 • 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

CS499	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

Computer and Network Security

CS449	Computer and Network Security	3-0-0-6	Pre-requisites: CS341, CS348

Overview, vulnerabilities, risk assessment, incidents. Cryptography: Classical Cryptography, Symmetric Cryptography, Public Key (Asymmetric cryptography), Modern Cryptography, Hash Functions, Key Exchange. Review: Installing Unix and common service daemons (Unix Security, Windows NT Security, Ping, traceroute, TCP Dump, sniffer etc.), Networking. Security issues: Terminology (Integrity, Availability, Confidentiality, Non-repudiation, Authentication, Authorization/Access Control, accounting, auditing, Passive and Active Attacker, Interruption, Interception, Modification, Fabrication, Social Engineering), Vulnerabilities and Counter Measures (Viruses, worms, Trojan horses, backdoors, unused services, buffer overflows, RPC), Exploits (Buffer overflow, Port Scanning etc). Applications Security (System Security, Audit Logs Intrusion Detection, Wrappers, Password and remote authorization tools e.g. PGP, S/MIME, SSH, Netscape/SSL, SET, IPsec, Kerberos, Firewalls, VPN etc, Secure (commerce) Transaction over a network, Network Anonymity.

Texts:
W. Stallings, Cryptography and Network Security: Principles and Practice, 3rd Ed, Prentice Hall, 2003.

References:

- B. Schneier, Applied Cryptography, 2nd Ed, John Wiley & Sons, Inc., 1996.

- A. Menezes, P. van Oorshot and S. Vanstone, Handbook of Applied Cryptogrphy, CRC Press, 1997.
- C. Kauffman, R. Perham and M. Speciner, Network Security: Private Communication in a Public World, Prentice-Hall, 1994.
- H. C. A. van Tilborg, Fundamentals of Cryptology, Kluwer Academic Publishers, 2000.
- P. Garrett, Making and Breaking Codes: An Introduction to Cryptology, Prentice-Hall, 2001.
- P. Wayner, Disappearing Cryptography, 2nd Ed, Morgan Kaufmann, 2002.
- W. Cheswick, S. Bellovin and A. Rubin, Firewalls and Internet Security. Repelling the Wiley Hacker, 2nd Ed, Addison-Wesley, 2003.
- Related publications in Journals/Conferences.

Internet Protocols

| CS452 | Internet Protocols | 3-0-0-6 | Pre-requisites:CS348 |

Overview of IPv4, TCP, IPv6, ICMP, ARP, DHCP; Routing Protocols: OSPF, RIP, BGP, Ad hoc network routing (AODV, DSR); IP Security: NAT, IPSEC, Socks, SSL; Quality of Service related protocols: Intserv, diffserv, Queuing techniques (WFQ, RED, etc.); Multi-Protocol Label Switching (MPLS) and GMPLS; Virtual Private Network (VPN) Protocols: L2TP, PPTP; Overview of Application Layer Protocols: DNS, LDAP, SMTP, POP3, IMAP4, SNMP; Voice over IP Protocols (VOIP) and videoconferencing: SIP, H323. Server Load Balancing Techniques

Texts:
Adolfo Rodriguez, et. al, *TCP/IP Tutorial and Technical Overview*, IBM Redbook, available online at
http://www.redbooks.ibm.com/pubs/pdfs/redbooks/gg243376.pdf, 2001

References:

- Charles. M.Kozierek, TCP/IP Guide, Shroff Publishers, Mumbai, 2005.
- Uyless Black, MPLS and Label Switching Networks, Pearson Education (LPE), 2002.
- Request for Comments (RFC) from www.ietf.org

Wireless Sensor Networks

| CS453 | Wireless Sensor Networks | 3-0-0-6 | Pre-requisites:Nil |

Introduction to ad hoc networks. Routing- Proactive routing protocols, Reactive routing protocols, backbone, Position based routing, power efficient routing; Introduction to sensor networks and its applications: Architecture and factors influencing the sensor network design. Routing protocols- data centric routing protocols, hierarchical routing protocols, location based routing, energy efficient routing etc; Node Scheduling and coverage issues, topology control. Querying, data collection and processing, Collaborative information processing and group connectivity. Target tracking and identity management using sensor networks. Localization . Application & future research Challenges.

Texts:
Adolfo Rodriguez, et. al, *TCP/IP Tutorial and Technical Overview*, IBM Redbook, available online at
http://www.redbooks.ibm.com/pubs/pdfs/redbooks/gg243376.pdf, 2001

References:

- Wireless Sensor Networks : A systems perspective By Nirupama Bulusu and Sanjay Jha, editors Artech House, August 2005.
- F. Zhao and L. Guibas. Wireless Sensor Networks: An Information Processing Approach. Elsevier/Morgan-Kaufmann, 2004.
- Wireless Sensor Networks : Architecture and Protocols By Jr., Edgar H. Callaway.
- Wireless Sensor Networks, An Edited Book Editors : C.S Raghavendra, Krishna M. Sivalingam and Taieb Znati.

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.

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

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

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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

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