ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

PG Syllabus (Effective from 2023-24)

(APPENDIX-I)

LIST OF (AC/ MC/ *OE) SUBJECTS OFFERED BY SCHOOLS/ DEPARTMENTS

School/ Department (Offering)	Subject Type	Subject Code	Subject Name
Basic Science and Humanities	AC 1	BH6001	English for Research Paper Writing
		BH6003	Sanskrit for Technical Knowledge
		BH6005	Value Education
		BH6007	Constitution of India
	AC 2	BH6002	Pedagogy Studies
		BH6004	Stress Management by Yoga
		BH6006	Personality Development through Life Enlightenment Skills
Infrastructure and Planning	AC 2	IP6002	Disaster Management

School/ Department (Offering)	Subject Type	Subject Code	Subject Name
Basic Science and Humanities	MC 1	BH6401	Mathematical Methods in Engineering
Mechanical Sciences	MC 2	MS6403	Research Methodology and IPR

School/ Department (Offering)	Subject Type	Subject Code	Subject Name
Basic Science and Humanities	*OE 1	BH6302	Spectroscopic Techniques for Organic Compounds
		BH6304	Chemical Biology
		BH6306	Nanoscience and Technology
		BH6308	Statistical Methods
		BH6310	Operations Research
		BH6312	Advanced Numerical Methods
Computer Sciences	*OE 1	CS6302	Pattern Recognition
		CS6304	Distributed Systems
		CS6306	Microfluidic Biochip
		CS6308	Programming in C
		CS6310	Data Structure
		CS6312	Computer Vision
Electrical Sciences	*OE 1	EE6302	Quantitative Methods for Energy Management and Planning
		EE6304	Soft Computing application to Engineering
		EE6306	Illumination Engineering
		EE6308	AI and ML for Biomedical Sciences
Electronic Sciences	*OE 1	EI6302	Machine Learning and Artificial Intelligence
		EI6304	IoT and its Applications
		EI6306	Parallel Processing
		EI6308	Signal Processing in Mechatronics Systems
		EI6310	Micro Electro Mechanical Systems
Infrastructure and Planning	*OE 1	IP6302	Universally Accessible Built Environments
		IP6304	Environment Impact Analysis
		IP6306	Geotechniques for Waste Materials
		IP6308	Project Planning and Management
Mechanical Sciences	*OE 1	MS6302	Production Planning and Control
		MS6304	Design of Experiment
		MS6306	Total Quality Management and Six Sigma
		MS6308	Financial Institutions, Instruments and Markets
		MS6310	Renewable Energy Systems
		MS6312	Design of Thermal Systems
		MS6314	Sensors and Actuators in Industry
		MS6316	Robot Mechanics and Control
Biotechnology	*OE 1	BT6302	Nanobiotechnology
Textile Engineering	*OE 1	TE6302	Polymer Composite

***N.B.:**

The Open Elective Subject for a particular Program/ Specialization of a School/ Department, is to be selected out of the above mentioned list of Open Elective Subjects (*OE 1), being offered by other Programs/ Specializations of various Schools/ Departments.

AC 1	BH6001	English for Research Paper Writing	2	0	0	0

Coruse Objectives:

To enable students:

i) acquire the skill to write research papers with clarity, in a persuasive style and in an ethical manner.
ii) identify a research problem and research questions, adopting appropriate methodology
iii) learn nitty-gritty of paragraph development, sentence structure, abstract, referencing etc.

Modules I:

Introduction to research, importance of English for research writing, Planning and preparation, identifying research problem, research questions, structuring paragraph, developing a persuasive style in writing, objectivity, avoiding ambiguity etc.

Modules II:

Literature review/survey, writing introduction, result discussion, analyzing findings, conclusion and various sections.

Modules III:

Abstract, title, key-words, referencing/bibliography, indexing/impact factor, research ethics, plagiarism (self-plagiarism), Anti-Plagiarism software and tools (e.g. Turn-it-in) etc.

Course Outcome:

i) Develop skills of cohesion and coherence in Research writing.
ii) Develop clarity of thought while choosing a topic.
iii) Identify research problem and questions.
iv) Develop skills in referencing and structure of a research document.

Text Books:

1. Goldbort R *Writing for Science*, Yale University Press (available on Google books): 2006
2. Day R: *How to write and Publish a Scientific Paper*, Cambridge University Press :2006
3. Adrian Wallwork, *English for Writing Research Papers*, Springer New York, 2011

Reference books:

1. S.C. Parja & Vikram Kate. *Writing and Publishing a Scientific Research Paper*. Springer: 2017.
2. Highman N, *Handbook of Writing for the Mathematical Sciences*, Highman's Book: 1998.
3. Chicago Manual of Style- 17th edition https://umanitoba.ca/student/academiclearning/media/CMS17-2018.pdf

AC 1	BH6003	Sanskrit for Technical Knowledge	2	0	0	0

AC 1	BH6005	Value Education	2	0	0	0

AC 1	BH6007	Constitution of India	2	0	0	0

AC 2	BH6002	Pedagogy Studies	2	0	0	0

AC 2	BH6004	Stress Management by Yoga	2	0	0	0

AC 2	BH6006	Personality Development through Life Enlightenment Skills	2	0	0	0

AC 2	IP6002	Disaster Management	2	0	0	0

Course Objectives:

1. To make the students understand the concepts of disasters and its classification.
2. To make the students understand the impact of disaster.
3. To understand emerging approaches in Disaster Management.
4. To make the students apply the knowledge of disaster management.

Module–I

Introduction: Concepts and definitions: Disaster, hazard, vulnerability, resilience, risks, frequency and details, capacity, impact, prevention, mitigation.

Disasters: Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); man-made disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility. Disaster Impacts: Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability, etc. Dos and Don'ts during various types of Disasters.

Module–II

Disaster Risk Reduction (DRR): Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment. Emerging approaches in Disaster Management - Three stages: Pre-disaster stage (preparedness), Emergency stage and Post Disaster stage – Rehabilitation. Roles and responsibilities of government, community local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programs in India and the activities of National Disaster Management Authority.

Module–III

Disasters, Environment and Development: Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods. Disaster management: Applications and case studies - Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

Text/Reference Books:

1. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012.
2. Pradeep Sahni, "Disaster Mitigation: Experiences and Reflections", Prentice Hall, 2004.
3. Singhal J.P. "Disaster Management", Laxmi Publications, 2010.
4. Donald Hyndman & David Hyndman, "Natural Hazards & Disasters", Cengage Learning, 2010.
5. Singh B.K., Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication, 2008.
6. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.

Course Outcomes:

CO1: Understand the Concepts of Disaster and its impact.
CO2: Apply the Dos and Don'ts during various types of Disasters.
CO3: Analyze the Disaster Risk Reduction: structural and non-structural measures
CO4: Understand the Rehabilitation, roles and responsibilities of government for Disaster Management
CO5: Design a sustainable and environment friendly recovery
CO6: Adapt various Case Studies and Inputs for Disaster Mitigation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	L	M	M	M	M	H	H	H	H	H	L	L	L	H	M
CO2	L	M	M	M	M	H	H	H	H	H	L	L	L	H	M
CO3	L	M	M	M	M	H	H	H	H	H	L	L	L	H	M
CO4	L	M	M	M	M	H	H	H	H	H	L	L	L	H	M
CO5	L	M	M	M	M	H	H	H	H	H	L	L	L	H	M
CO6	L	M	M	M	M	H	H	H	H	H	L	L	L	H	M

MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3

Module I:
Linear Algebra: Preliminary idea on Vector space, solvability of Ax = b by Gauss Elimination Method, orthogonality and QR transformation; Eigenvalues and eigenvectors, similarity transformation, Fourier series, Fourier Transformation.
Optimization Techniques: Introduction to LPP, Simplex method, Big-M Method, Revised Simplex method, Concept of Duality.

Module II:
Matrix Theory: Norms and spaces, Special Matrices and their properties, least squared and minimum normed solutions.
Matrix Decomposition Algorithms: LU decomposition method, Singular value decomposition (SVD), low-rank approximations, Gram-Schmidt process, polar decomposition.
Dimensions Reduction Algorithms: Principal component analysis, linear discriminant analysis, minimal polynomial, and Jordan canonical form.
Calculus: Basic concepts of calculus**,** Jacobian, Hessian, convex sets, convex functions, and their properties.

Module III:
Numerical Methods: Solution of ODEs by Multistep methods: Adam-Bashforth method, Adam-Moulton Method, Solution of PDEs: Elliptic, parabolic and hyperbolic.
Recurrence Relations and Generating Functions: Method of Characteristic Roots, Solving homogeneous and Inhomogeneous Recurrence Relations.
Probability: Basic concepts of probability: Conditional probability distribution, Marginal probability distribution, joint distributions, covariance, correlation and regression.

Text Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig,10th Edition., Wiley-India
2. Linear Algebra and its Application, 4th Edition., G. Strang, S. Chand (G/L) & Company Ltd, 2005.
3. Fundamentals of Matrix Computations, David S. Watkins, Wiley Publication, 2004.
4. Discrete Mathematics and its Applications with Combinatorics and Graph Theory, K.H. Rosen, 7th Edition., Tata McGraw Hill.

Reference Books:

1. A First Look at Rigorous Probability Theory, Jeffery S. Rosenthal, 2ndEdn., Singapore: World Scientific Publishing, 2006.
2. Mathematics for Machine Learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 2020.
3. Linear Algebra, 4thEdn., S. Lipschutz, M.L. Lipson, Schaums Outline Series, Mc Graw Hill.
1. Applied Mathematical Methods 1st Edition, Kindle Edition, Bhaskar Dasgupta.
2. Numerical Analysis, Richard L. Burden, J. Douglas Faires, Annette M. Burden, Cengage Learning Publication, 2015.
3. Probability and Statistics for Engineers and Scientists, 9th Edition., R.E. Walpole, R.H. Myers, S.L. Myers, K. Le, Prentice Hall.

Course Outcomes:
CO1: Understand and apply concepts of linear algebra, matrix theory and have adequate knowledge of Fourier series and transform.
CO2: Implement appropriate techniques to solve different problems on optimization.
CO3: Apply various techniques of Numerical Methods to solve ODEs, PDEs, and DEs. Understand few concepts on multivariable calculus.
CO4: Use Probability theory & Statistics in problem solving.

MC 2	MS6403	Research Methodology and IPR	3	0	0	3

Course Outcomes:

CO1: Understood the Meaning of research problem, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

CO2: Got the knowledge of How to get new ideas (Criticizing a paper) through the Literature Survey (i.e. Gap Analysis).

CO3: Understood the Filing patent applications- processes, Patent Search, Various tools of IPR, Copyright, Trademarks.

CO4: Understood How to apply for Research grants and Significance of Report Writing, Steps in Report Writing, Mechanics and Precautions of Report Writing, Layout of Research Report.

CO5: Got the knowledge of How to write scientific paper & Research Proposal - Structure of a conference and journal paper, how (and How Not) to write a Good Systems Paper:

Module I:

Introduction to RM: Meaning and significance of research. Importance of scientific research in decision making. Types of research and research process. Identification of research problem and formulation of hypothesis. Research Designs. Types of Data: Primary data Secondary data, Design of questionnaire; Sampling fundamentals ad sample designs, Methods of data collection, Measurements and Scaling Techniques, Validity & Reliability Test.

Module II:

Data Processing and Data Analysis-I, Data editing, Coding, Classification and Tabulation, Descriptive and Inferential Analysis, Hypothesis Testing- Parametric Test (z test, t test, F test) and non-parametric test (Chi square Test, sign test, Run test, Krushall-wallis test).

Module III:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Reference Books:

1. Research Methodology, Chawla and Sondhi, Vikas
2. Research Methodology, Paneerselvam, PHI

OE 1	BH6302	Spectroscopic Techniques for Organic Compounds	3	0	0	3

OE 1	BH6304	Chemical Biology	3	0	0	3

OE 1	BH6306	Nanoscience and Technology	3	0	0	3

Module-I

Nanostructured Materials:
Classification based on spatial extension (0-D, 1-D, 2-D), Surface to volume ratio and quantum confinement, Density of states, Preparation of quantum nanostructures (top-down and bottom-up approach), Size effects, Excitons, Single electron tunneling, Applications: infrared detectors, Quantum Dot Lasers

Properties of individual Nanoparticles:
Metal nanoclusters: Magic numbers, Theoretical modelling of nanoparticles,Geometric structure, Electronic structures, reactivity, fluctuations, magic clusters, Bulk to nanostriction
Semiconducting Nanoparticles: Optical properties, photo fragmentation, Coulombic explosion, Photoluminescence, thermo luminescence

Module-II

Carbon nanostructures
Carbon molecules: Nature of the carbon Bond, New carbon structures Small Carbon Clusters, Discovery of C60, Structure of C60 and its crystal, Alkali doped C_{60} , Larger and Smaller Fullerenes, Other Bucky ball

Carbon nanotubes:
Fabrication, Structure, Electrical properties, Vibrational properties, Mechanical properties
Applications of carbon nanotubes: Field emission and shielding, computers, Fuel cells, Chemical Sensors, Catalysis, Mechanical Reinforcement

Module-III

Bulk Nanostructured materials:
Solid Disordered Nanostructures: Methods of synthesis,Failure mechanism of Conventional Grain- Sized Materials, Mechanical properties, Nanostructured Multilayers, Electrical properties, Other properties, Metal Nanocluster Composite Glasses, Porous Silicon
Nanostructured Crystals: Natural Nanocrystals, Computational Prediction of Cluster Lattices, Arrays of nanoparticles in Zeolites, Crystals of Metal Nanoparticles, Nanoparticle Lattices in Colloidal suspensions, Photonic Crystals
Physical Properties of Nanostructured Materials: Effect of size reduction on magnetic and electric behavior of materials, Dynamics of nanomagnets, Ferro fluids

BOOK:

1. Introduction to Nanotechnology: Charles P. Poole, Jr., Frank J. Owens
2. Nanocrystal Quantum dots by Victor I. Klimov (Second Edition)
3. Solid State Physics by C. Kittel (Eigth Edition)

OE 1	BH6308	Statistical Methods	3	0	0	3

Prerequisites: Probability, Statistics.

Module-I:
Multivariate normal distribution, Multinomial distribution, Covariance Matrix, Chi Square, t and F distributions, The Sample Mean and the Sample Variance, testing of hypothesis (parametric and non-parametric, multiple testing, large scale hypothesis testing) and assessing goodness of fit,

Module-II:
Linear methods for Regression and Classification: Overview of supervised Learning, Linear regression models and least squares, Multiple Regression, Subset selection, Ridge regression, least angle regression and Lasso, Linear discriminant analysis, Logistic regression.
Unsupervised Learning: Cluster analysis, Principal Components analysis.

Module-III:
Generalized additive models, Regression and Classification trees, Boosting Methods- exponential loss and Ada Boost, Cross validation, Bootstrap, Random forests and analysis, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest Neighbor classifiers. Model Selection,

Text Books
1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning-Data Mining Inference and Prediction, Second Edition, Springer Verlag, 2009.
2. John A. Rice, "Mathematical Statistics and Data Analysis" third edition, Cengage Learning.

References
1. C.M. Bishop- Pattern Recognition and Machine Learning, Springer,2006.
2. L. Wasserman- All of statistics

Course Outcomes: - After the successful completion of this course the students will be able to
1. Understand the concepts of various distributions in statistics and their limitations.
2. Understand modern notions in data analysis-oriented computing;
3. Application of common Supervised & Unsupervised Learning algorithms for various real time problems;
4. Better understanding of distributed computing.

OE 1	BH6310	Operations Research	3	0	0	3

Prerequisites: Linear Algebra.

Module-I:
Modeling of problems and principle of modeling. Introduction to Linear programming, Sensitivity analysis in linear programming. Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method.
Assignment problems: Hungarian method for solution of Assignment problems.

Module –II:
Integer Programming: Branch and Bound algorithm for solution of integer Programming Problems.
Simulation and Modeling: Introduction to simulation and modeling. Markov analysis: Introduction to markov processes, State and Transition Probabilities, Transition Diagram, n-step transition probabilities,
Game theory.

Module –III:
Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, Multiple server, Finite sources, Queue discipline.
Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Constrained optimization with inequality constraint: Kuhn-Tucker condition.

Text Books:

1. Kanti Swarup, P. K. Gupta, Man Mohan, "Operations Research", Sultan Chand and Sons
2. A. Ravindran, D. T. Philips, J. Solberg, "Operations Research- Principle and Practice", Second edition, Wiley India Pvt. Ltd

Reference Books:

1. Stephen G. Nash, A. Sofer, "Linear and Non-linear Programming", McGraw Hill
2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis," Engineering Optimization", Second edition, Wiley India Pvt. Ltd
3. H.A.Taha,A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, "Operations Research", Eighth Edition, Pearson Education
4. F.S.Hiller, G.J.Lieberman, "Operations Research", Eighth Edition, Tata McGraw Hill
5. P.K.Gupta, D.S.Hira, "Operations Research", S.Chand and Company Ltd.

Course Outcomes: After the successful completion of this course the students will be able to
1. Identify and develop operational research models from the verbal description of the real system.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.
4. Develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

OE 1	BH6312	Advanced Numerical Methods	3	0	0	3

Prerequisites: Numerical Methods.

Module –I:
Solution of Equations: Zeros of Polynomials, Horner's method, Muller's method, Interpolation & Polynomial Approximation: Lagrange polynomial, Data approximation Hermite, cubic spline and piecewise interpolation (Natural cubic splines, clamped Splines)
Numerical differentiation& Integration: Numerical differentiation, Richardson Extrapolation.
Numerical Integration & Composite Integration (Newton Cotes & Gaussian Quadrature), Romberg Integration, brief idea of Adaptive quadrature method, Asymptotic error formula, Multiple Integrals, Improper Integrals,

Module –II:
Numerical solution to ODE; Taylor's series methods, Adaptive Runge - Kutta method, predictor- corrector method, convergence and stability, multistep methods.
Boundary value problem for ODE: Shooting method for linear & non-linear problems, finite difference methods for linear & non-linear problems, The Rayleigh- Ritz method.

Module –III:
Approximating Eigen value: power method, shifted power method, inverse power, Householder's method, QR-method, error and stability.
Numerical solution to partial differential equations: Solution of parabolic, elliptic, Hyperbolic differential equations using finite difference method and stability considerations.

Text Book:
1. Numerical Analysis: Richard L. Burden & J.D.Faires.
   Cengage Learning 9th Edition (chapter –2(2.6), chapter-3(3.1,3.2,3.4-3.6),chapter4(4.1-4.9),chapter-5(5.1-5.8,5.10),Chapter9(9.1-9.5),chapter-11(11.1-11.5),chapter12(12.1-12.3))

Reference Books:
1. Numerical methods, Srimanta Pal, Oxford Higher Education.
2. Numerical methods for Scientific and Engineering Computation, M.K.Jain, S.R.K.Iyengar (5^{th} edition).
3. Numerical methods for Engineers by Chapra & Canale, TMH
4. An introduction to Numerical Analysis: by Kendall E. Atkinson, Wiley

Course Outcomes: After the successful completion of this course the students will be able to
1. Solve an algebraic or transcendental equation and differential equation (ODE & PDE) using an appropriate numerical method.
2. Approximate a function using an appropriate numerical method.
3. Evaluate a derivative at a value and a definite integral using an appropriate numerical method.
4. Solve a linear system of equations using an appropriate numerical method.

OE 1	CS6302	Pattern Recognition	3	0	0	3

Course Outcomes:

CO1: Summarize the various techniques involved in pattern recognition
CO2: Categorize the various pattern recognition techniques into supervised and unsupervised.
CO3: Illustrate the artificial neural network based pattern recognition
CO4: Discuss the applications of pattern recognition in various applications

Module-I

Fundamental concepts and blocks of a typical pattern recognition system. Decision functions-role and types, pattern and weight space, properties and implementation of decision functions. Feature identification, selection and extraction. Distance measures, clustering transformation and feature ordering, clustering in feature selection, feature selection through maximization and approximations.

Module-II

Pattern classification by distance functions. Clusters and cluster seeking algorithms. Pattern classification by likelihood functions. Baye's classifier and performance measures.

Module III

Artificial neural network model, Neural network-based pattern associators, Feed forward networks and training by back-propagation- ART networks.
Applications of statistical and neural network – based pattern classifiers in speech recognition, image recognition and target recognition.

Text Books:

J.I. Tou & R.C. Gonzalez, Pattern Recognition Priciples, Addition-Wesley.
R. Schalkoff, Pattern Recognition - Statistiucal, Structural and Neural Approaches, John Wiley, 1992.

Reference Books:

P.A. Devijer & J. Kittler, Pattern Recognition - A Statistical Approach, Prentice-Hall.
Christopher. M. Bishop, 'Pattern recognition and machine learning, Springer, 2006.

OE 1	CS6304	Distributed Systems	3	0	0	3

Course Objectives

This course provides an insight into Distributed systems.

Topics include- Peer to Peer Systems, Transactions and Concurrency control, Security and Distributed shared memory

Course Outcomes

Ability to understand Transactions and Concurrency control.

Ability to understand Security issues.

Understanding Distributed shared memory.

Ability to design distributed systems for basic level applications.

MODULE-I

Characterization of Distributed Systems-Introduction, Examples of Distributed systems, Resource sharing and web, challenges, System models -Introduction, Architectural and Fundamental models, Networking and Internetworking, Interprocess Communication, Distributed objects and Remote Invocation-Introduction, Communication between distributed objects, RPC.

MODULE-II

Operating System Support-Introduction, OS layer, Protection, Processes and Threads, Communication and Invocation, operating system architecture, Distributed File Systems-Introduction, File Service architecture.

MODULE-III

Transactions and Concurrency Control-Introduction, Transactions, Nested Transactions, Locks, Optimistic concurrency control, Timestamp ordering. Distributed Transactions-Introduction, Flat and Nested Distributed Transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery.

TEXTBOOKS:

1. Distributed Systems Concepts and Design, G Coulouris, J Dollimore and T Kindberg, Fourth Edition, Pearson Education.
2. Distributed Systems, S.Ghosh, Chapman & Hall/ CRC, Taylor& FrancisGroup, 2010.

REFERENCEBOOKS:

1. Distributed Systems – Principles and Paradigms, A.S. Tanenbaum and M.V. Steen, Pearson Education.
2. Distributed Computing, Principles, Algorithms and Systems, Ajay D. Kshemakalyani and Mukesh Singhal, Cambridge, rp 2010.

OE 1	CS6306	Microfluidic Biochip	3	0	0	3

Pre-requisite:
Knowledge of digital logic design, computer architecture and microprocessors, design and analysis of algorithms
Course Objective:
To introduce the concepts and techniques used in computer-aided design of VLSI chips, embedded system design, fault-tolerant system design and in other emerging technologies, e.g., microfluidic chips, 3D ICs,quantum computers, etc.

Module-I
Introduction: VLSI design flow, challenges. Technology Issues: Digital Microfluidic Biochips, Lab-on-a-Chips (LoCs), Continuous-Flow Microfluidics (CMF) and Digital Microfluidics (DMF), Their Working Principles, Some Real-Life Bioprotocols, Fundamentals of DMF Biochips, Microfluidic Biochip Design Challenges

Module-II
Logic synthesis: two-level and multi-level logic optimization of combinational circuits, state assignment of finite state machines. Basic concepts of high-level synthesis: architectural models, scheduling, allocation and binding. Physical design automation algorithms: partitioning, floor planning, placement and routing. layout compaction, design rule check, power and delay estimation, clock and power routing, etc., special considerations for analog and mixed-signal designs

Module-III
Droplet Routing: Background, Problem Formulation, Routing Method, Experimental Evaluation, Special topics of above items Protocol Derivation for Sample Preparation using DMF Biochips: Basic Preliminaries, Dilution, Mixing, Layout Design of Sample Preparation Related topics: basic concepts, of verification, embedded system design techniques, hardware-software code sign, fault-tolerant system design Introduction to CAD Tools for Biochips: Bio Coder by Microsoft, DMFBSSS by University of California Riverside

Text Books/Reference Books:
1. G. D. Micheli, Synthesis and Optimization of Digital Circuits, McGraw Hill, 2003.
2. N. A. Sberwani, Algorithms for VLSI Physical Design Automation, Kluwer Academic Publishers, 1999.
3. D. D. Gajski, N. D. Dutt, A.C. Wu and A.Y. Yin, High-level Synthesis: Introduction to Chip and System Design, Kluwer Academic
Publishers, 2012.
4. S. M. Sait and H. Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific, 2010.
5. K. Chakrabarty and F. Su, Digital Microfluidic Biochips: Synthesis, testing and Reconfiguration Techniques. Boca Raton, FL: CRC
Press, 2007.

Mainly based on technical papers from journals and conference proceedings, such as TCAD, TVLSI, TCBB, DAC, ICCAD, ISPD, ISLPED

OE 1	CS6308	Programming in C	3	0	0	3

Course Objectives:
1. To provide understanding of algorithmic approach to problem solving.
2. To provide knowledge on Procedural Approaches to program design.
3. To provide elaborate knowledge on C language to write procedural programs.

Course Outcomes:
On successful completion of the course, the students will be able to:
1. Develop skills to write computer programs to solve a variety of real-world problems.
2. Write programs using procedure oriented approach
3. Design programs using readable, reusable and cohesive modules.
4. Develop skills to use pointers and data files in programs.

Course Prerequisites:
1. This course does not require any prerequisite as such.

Module I
Program Development: Programming as Problem-Solving, Steps in Program Development, Algorithm, Flowchart, Pseudo code, Top-down and Bottom-up approaches, Characteristics of a good program, Structure of a C Program, Compiling, Linking and Executing Programs. C Language Fundamentals: Language Elements, Data Types, Variables and Constants, Operators, Expressions, Type Conversions, Statements, Managing Console Input and Output Operations, Function. Control Structures: Decision Making and Branching - If and Switch, Loop Structures - While, Do While and For, Unconditional Jumps - Continue, Break and Go To.

Module II
Arrays and Strings: Concept, Declaration and Manipulation of Arrays, One Dimensional and Multidimensional Arrays, Sorting and Searching an Array, Concept of Strings, String Handling Functions, Array of Strings. Pointers: Pointer Variable and its Importance, Dereferencing, Pointer Arithmetic and Scale Factor, Pointers and Arrays, Pointer and Strings, Array of Pointers, Pointers to Pointers. Functions: Designing Structured Programs, User Defined and Standard Functions, Formal and Actual Arguments, Function Prototype, Parameter Passing, Functions Returning Multiple Values, Functions Returning Pointers, Pointers to Functions, Nesting of Functions, Recursion, Passing Arrays to Functions. Scope and Extent: Scope Rules, Storage Classes - Auto, Extern, Register and Static.

Module III
Structures, Unions and Enumerations: Declaration and Initialization of Structures, Structure as Function Parameters, Structure Pointers, Unions, Enumerations. File I/O: Defining, Opening a File and Closing a File, Input/output Operations in Files, Random Access to Files, Error Handling. Command Line Arguments, Dynamic Memory Management.

Text Book:

1. Jeri R. Hanly and Elliot B. Koffman, Problem Solving and Program Design in C, 8th Edition, Pearson Education, 2016. (Module-I, II, III)

Reference Books:

1. R. G. Dromey, How to Solve it by Computer. Prentice-Hall India EEE Series.
2. E. Balagurusamy, Programming in ANSI C, 4th edition, McGraw-Hill Publication,2007.
3. PradipDey, ManasGhosh, Programming in C, Second Edition,OxfordUniversity Press, 2011.
4. Brian W. Kernighan, Dennis Ritchie, The C Programming Language, 2nd Edition, Prentice Hall, 1988.
5. Yashavant P. Kanetkar. Let Us C, BPB Publications, 2011.
6. Byron S Gottfried, Programming with C, Schaum's Outlines, Second Edition, Tata McGrawHill, 2006.

OE 1	CS6310	Data Structure	3	0	0	3

Course Objectives:
1. To provide knowledge and understanding of various basic and advanced data structures available in computing domain.
2. To provide skills to write programs to implement various data structures using procedural or object oriented programming languages.
3. To provide knowledge to analyze problems in application domains and design solution using data structures.

Course Outcomes:
On successful completion of the course, the students will be able to:
1. Be well-versed in various standard data structures available in computing domain.
2. Write programs to perform operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
3. Analyze problems; choose the appropriate data structures and write program solutions to problems in specified applications using such data structures.

Course Prerequisites:
This course requires understanding of computer programming in any language.

Detailed Syllabus:

Module I
Fundamentals: Introduction to Data Structures, Classification of Data Structures, Algorithms, Measuring Space and Time Complexities, Asymptotic Notations, Abstract Data Types.
Arrays: Storage Structures for Arrays, Sparse Matrixes, Strings, Pattern Matching.
Stacks and Queues: Representation, Operations on Stacks and Queues, Applications of Stack and Queues.
Linked Lists: Dynamic Memory Management, Single Linked Lists, Double Linked Lists, Circular Linked Lists, Linked Stacks and Queues, Operations on Polynomials.

Module II
Trees: Terminology, Representation, Binary Trees, Binary Search Trees, Searching, Insertion and Deletions Operations in a Binary Search Tree, Height Balanced Trees, M-way Search Trees, B-Trees, B+ Trees, General Trees, Representation of General Trees and Binary Trees, Forests, Application of Trees.

Module III
Graphs: Terminology, Representation, Path Matrix, Graph Traversal, Shortest Path Problems, Topological Sort.
Searching and Sorting Techniques: Linear and Binary Search, Bubble Sort, Insertion Sort, Selection Sort, Quick Sort, Merge Sort, Heap and Heap Sort, Radix Sort, Comparison of Sorting Techniques.
Hashing: Hash Functions and Hashing Techniques, External sorting.

Text Books:

1. Tremblay, Jean-Paul, and Paul G. Sorenson, "An introduction to data structures with applications", McGraw-Hill.
2. Aaron M. Tenenbaum, Data Structures Using C

Reference Books:

1. Richard F. Gilberg & Behrouz A. Forouzan, Data Structures A Psedocode Approach with C, Second Edition, CENGAGE Learning.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press Pvt. Ltd.
Seymour, Lipchitz. “Data Structures with C.” TMH

OE 1	CS6312	Computer Vision	3	0	0	3

Module I:
Digital Image Formation and low-level processing Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc.; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. Depth estimation and Multi-camera views Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. apparel

Module II:
Feature Extraction Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners – Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale- Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Module III:
Pattern Analysis Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods. Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Shape from X Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Text Books:
1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, PearsonEducation, 2003.

References:
1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

OE 1	EE6302	Quantitative Methods for Energy Management and Planning	3	0	0	3

COURSE OBJECTIVES:

1. To understand the fundamentals of Energy management
2. To analyze different strategies of Energy Management Planning
3. To gain knowledge issues in energy management systems which deal with both deterministic and non-deterministic problems

COURSE OUTCOMES: Students completing this course will be able to:
CO 1: Gain knowledge on optimization terminology and concepts.
CO 2: Apply optimization methods for energy planning, including developing a model, defining an optimization problem, applying optimization methods, exploring the solution and interpreting results.
CO 3: Explain methods for energy management and planning and arriving at an optimal configuration during real time operation.

MODULE I:

Necessity of energy management and formulation of the problem, Quantifying optimal conditions through: Graphical method, Simplex method and Matrix method. Sensitivity analysis, primal and duality.

MODULE II:

Basic principles of probability and calculus of variations, Curve fitting, Lagrange multipliers (gradient and Newton's method), search methods, secant method, steepest ascent and steepest descent along with local and global optimum.

MODULE III:

Introduction to different classes of optimization through simple problems: (a) Linear and nonlinear programming (b) Deterministic and stochastic programming (c) Quadratic and geometric programming (d) Integer and real-valued programming (e) Single- and multiple-objective programming (f) Constrained and unconstrained programming.
Sequencing, queuing theory, networks, PERT and CPM, Levels of optimization of energy systems: single-level and multi-level optimization, Environment considerations in the optimization of energy systems. Case Studies on different scenarios based on the above techniques
.

Text Books:

[1]. Jaluria Y., Design and Optimization of Thermal Systems, CRC Press, 2nd edition (2008).
[2]. TahaH. A., Operations Research: An Introduction, Prentice-Hall of India Pvt. Ltd., 8th Edition (2007).
[3]. VohraN. D., Quantitative Techniques in Management, Tata McGraw-Hill (1997).
[4]. Bejan A., Tsatsaronis G., Moran M., Thermal Design and Optimization, Wiley Publications (1996).
[5]. Stoecker W. F., Design of Thermal Systems, McGraw Hill International Editions (1989).
[6]. Wagner H. M., Principles of Operations research with Application to Managerial Decisions, Prentice Hall (1969).

OE 1	EE6304	Soft Computing application to Engineering	3	0	0	3

Course Objectives:

- The main objective of the Soft Computing Techniques to Improve Data Analysis Solutions is to strengthen the dialogue between the statistics and soft computing research communities in order to cross-pollinate both fields and generate mutual improvement activities.
- Soft Computing is a consortia of methodologies which collectively provide a body of concepts and techniques for designing intelligent systems.

Module-I

Introduction: What is Soft Computing? Difference between Hard and Soft computing, Requirement of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing

Neural Networks: Introduction to Neural Network, Learning rules and various activation functions, Single layer Perceptrons, Back Propagation networks, Architecture of Backpropagation (BP) Networks, Backpropagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Applications.

Module-II

Fuzzy Systems: Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification,
Applications of Fuzzy Systems.

Module-III

Genetic Algorithm: History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization.
Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto approaches, Pareto-based approaches to solve Multi-level Optimization, Introduction to recent soft computing techniques, Applications.

Reference Books:

1. D. K. Pratihar, Soft Computing, Narosa Publishing House, 2008.
2. S. Haykin, Neural Networks: A Comprehensive Foundation, 2nd Ed, Pearson Education, 1999.
3. G. Chen and T. T. Pham, Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems, CRC Press, 2001.
4. K. Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2006.
5. R. A. Aliev, R. R. Aliev, Soft Computing and its Applications, World Scientific Publishing Co. Pte. Ltd., 2001.
6. S.Rajasekaran, G. A. Vijayalakshami, Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, PHI.
7. David E. Goldberg, Genetic Algorithms in search, Optimization & Machine Learning
8. Jang, Sun, Mizutani, Neuro-Fuzzy and Soft computing, PHI

OE 1	EE6306	Illumination Engineering	3	0	0	3

Course Objective: To make student understand the importance of illumination engineering in energy conservation and to guide them toward acquiring the knowledge regarding the fundamental aspects of artificial lighting.

Module-I
Basics of Illumination
Colour, radiation, eye, vision, components of illumination systems, introduction to sources of light: Daylight, Incandescent, Electric Discharge, Fluorescent, Arc Lamps, and Lasers

Module-II
Artificial Illumination
Switching and control circuits, wiring, luminaries, Laws of illumination, illumination from different type of sources: point, line and surface, Photometry, Spectrophotometry, and Photocells, Environmental interaction and glare

Module-III
Illumination Design
General illumination design, Interior lighting: industrial, residential, office, department stores, indoor stadium, theatres and Hospitals, Exterior Lighting: Flood, Street, Aviation, Transport Lighting, Displays, Signalling, Neon Signs, LED-LCD Displays, Beacons, and Surveillance Lighting

Text Books:

1. C.L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", Revised 3rd Edition, 2012, New Age International Publisher
2. R. K. Rajpur, "Utilization of Electrical Power (including electric Drives and electric Traction)", 1st Edition, Reprint 2012, Laxmi Publications (P) LTD
3 Chakrabarti, Soni, Gupta, Bhatnagar, "Power system Engineering", Dhanpatrai & Co., Second revised edition Boro, Reprint: 2014

Reference Books:

1. J.B. Gupta, R. Manglik, R. Manglik, "Utilisation of Electrical Energy and Traction", 1st Edition, 2012, S. K. Kataria and Sons
2. Tarlok Singh, "Utilization of Electric Energy", and Edition ,2018, S.K. Kataria & Sonsk

Online Reference:
- https://archive.nptel.ac.in/courses/108/105/108105060/

Course Outcomes:
1. Apply an appropriate measurement and analysis technique of artificial lighting for different specific purposes.
2. Investigate on various types of electric bulbs as well as can evaluate their performance in terms of their colour rendering and luminous efficacy.
3. Develop a clear idea on various illumination techniques and hence can design lighting schemes for specific applications.
4. Select as well as apply an appropriate light fitting method for any specific application.

OE 1	EE6308	AI and ML for Biomedical Sciences	3	0	0	3

Course Objectives:

1. To provide biomedical and healthcare domain specific knowledge for the applications of machine learning and artificial intelligence methodologies.
2. To provide computer and programming skills for building and implementing machine learning models.
3. To provide interdisciplinary knowledge on biomedical and healthcare data for successful application of artificial intelligence and machine learning techniques.

Course Outcomes:

On successful completion of the course, the students will be able to:

1. Understand biomedical terminologies, its relation to healthcare problems and challenges in biomedical data mining.
2. Apply machine learning and artificial intelligence tools to interpret biological and healthcare data.
3. Understand how machine learning algorithms can be employed to solve real-world clinical problems.

Course Prerequisites:

This course requires understanding of computer programming in any language.

Module I

Fundamentals: Basic concepts and principles of machine learning; Basics of linear algebra, probability and optimization; Introduction to Biomedical Systems and Databases; Introduction to Neural Networks, Supervised Learning, Unsupervised Learning, Ensemble Techniques.

Module II

Introduction to Clustering: Distance measures, Different clustering methods (Distance, Density, Hierarchical), Iterative distance-based clustering, Constructing a hierarchical cluster, K-Medoids, k-Mode and density-based clustering, Measures of quality of clustering;

Introduction to Classification: K-Nearest Neighbors, Naïve Bayes Classifier, Support Vector Machine, Decision Tre, Random forest, Gradient Boosting Machines and XGBoost, ANN Clasifier;

Introduction to feature selection techniques: Generating features for biomolecules and biomedical images, Principal Component Analysis for High-dimensional Datasets (e.g. microarray data).

Module III

Introduction to Deep Learning: Convolutional Neural Networks; Recurrent Neural Networks; Commonly Used and Advanced Neural Network Architectures; Application of machine learning and deep learning to genomic data, medical images or biomedical signals.

TEXT BOOKS

1. Shalev-Shwartz, Shai, and Shai Ben-David. Understanding Machine Learning: From Theory to Algorithms. Cambridge University Press, 2014.
2. Goodfellow I, Bengio Y, Courville A. Deep Learning. Cambridge: MIT Press; 2016.

REFERENCE BOOKS

1. S. Russel and P. Norvig, Artificial Intelligence: a Modern Approach, Pearson, 4t Ed, 2021
2. John D. Kelleher , Brian Mac Namee, Aoife D'Arcy, Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies, The MIT Press; 2nd edition, 2020
3. A. Aldo Faisal, and Cheng Soon Ong. Mathematics for Machine Learning. Cambridge University Pres; 2020

OE 1	EI6302	Machine Learning and Artificial Intelligence	3	0	0	3

Prerequisites:
Calculus, Linear Algebra, and Statistics

Course Outcomes:
Upon successful completion of this course, students will be able to:
1) Demonstrate the principles, advantages, problem of AI and implement in real field with different algorithms.
2) Solve problems using AI Knowledge and Reasoning.
3) Explain the principles, advantages, problems of ML and applications of ML.
4) Implement Artificial Neural Network and the different learning algorithm and deep learning

MODULE I
Principles of AI and Search Techniques: Introduction to AI, AI Problems, Planning, Production System, State Space Representation, Branches and Application of AI
Heuristic Search: Hill Climbing, Simulated Annealing, Depth First Search, Breadth First Search, Greedy Method, Best First Search, A* Algorithm, Problem Reduction: AND-OR graph, AO* Algorithm, Adversary Search: MINIMAX Algorithm, Alpha-Beta Cut-off algorithm.

MODULE II
Knowledge and Reasoning: Knowledge Management, Types of Knowledge, Knowledge Representation, First Order Logic: Basic Predicate Representation, Conversion of WFF to Clause Form, Resolution and its Problem,
Reasoning: Types of Reasoning, Non-Monotonic Inference Method and Reasoning, Truth Maintenance System, Rule Based Reasoning, Reasoning with Fuzzy Logic

MODULE III
Machine Learning (ML): Introduction to ML, Problems in ML, Learning System, Application of ML, Clustering: k-Means Clustering, Fuzzy and Hierarchical Clustering, Reinforcement Learning: Markov Decision Problem, Q-learning, Temporal Difference Learning, Statistical Learning: Hidden Markov Models, Linear, Quadratic Classifier, Decision Trees, Bayesian Networks
Artificial Neural Network: ANN, Types of Network, Perceptron, RBF Network, Supervised Learning: Support Vector Machines, Inductive Logic Programming, Case-Based Reasoning, Ensemble Classifier, Nearest Neighborhood, Fuzzy Network, RBF, Unsupervised Learning: Self Organizing Maps, Adaptive Resonance Theory, Deep Learning

TEXT BOOKS

3. E. Rich and K. Knight, Artificial Intelligence, Tata McGraw Hill.
4. Tom Mitchell, Machine Learning, McGraw Hill , 1997, ISBN 0-07-042807-7

REFERENCE BOOKS

4. S. Russel and P. Norvig, Artificial Intelligence: a Modern Approach, Pearson
5. Zsolt Nagy, Artificial Intelligence and Machine Learning Fundamentals

OE 1	EI6304	IoT and its Applications	3	0	0	3

Prerequisites:
Basic Knowledge in Computer Networks, OSI Model, Programming Skills

Course Outcomes:
At the end of this course, students will be able to
1. Interpret and apply the concept of IOT and M2M
2. Apply IoT architecture and applications in various fields
3. Apply the security and privacy issues in IOT.
4. Implement IoT Applications

MODULE I

Introduction to Internet of Things: Application areas of IoT, Characteristics of IoT, Things in IoT, IoT stack, Enabling technologies, IoT challenges, IoT levels, IoT and cyber-physical system, IoT and WSN.

Sensors, Microcontrollers, and Their Interfacing: Sensor interfacing, Types of sensors, Controlling sensors, Microcontrollers, ARM.

MODULE II

Protocols for IoT : Messaging protocols, Transport protocols, IPv4, IPv6, URI

Cloud for IoT: IoT and cloud, Fog computing, Security in cloud

Application Building with IoT: Various applications of IoT : Food, Healthcare, Lavatory maintenance, Water quality, Warehouse, Retail, Driver Assistance, Collision impact

MODULE III

Arduino and Raspberry Pi: Arduino : Architecture, Programming and Application

Raspberry Pi : Architecture, Programming and Application

IoT Security: Various security issues and need, architecture, requirement, challenges and algorithms

Text Books:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
2. Internet of Things, Vasudevan, Nagrajan and Sundaram, Wiley India

Reference Book:

1. IoT Fundamentals, David Hence at el, Cisco Press
2. Francis da Costa, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013.
3. Cuno Pfister, “Getting Started with the Internet of Things”, O. Reilly Media, 2011.

OE 1	EI6306	Parallel Processing	3	0	0	3

Prerequisites: Computer Network

Course Outcomes:
At the end of the course, the student will be able to,
1. Design and analyse the parallel algorithms for real world problems and implement them on available parallel computer systems.
2. Optimize the performance of a parallel program to suit a particular hardware and software environment.
3. Design algorithms suited for Multicore processor systems using Open CL, OpenMP, Threading techniques.
4. Analyse the communication overhead of interconnection networks and modify the algorithms to meet the requirements.

MODULE I
Introduction to Parallel Architectures: Why Parallel Architectures, Diversity and Convergence of Parallel Architectures, Fundamental Design Issues
Parallel Programming and Workload-Driven Evaluation: The Parallelization Process, Workload-Driven Evaluation

MODULE II
Cache Coherent Bus-Based Multiprocessors: Cache Coherence and Bus Snooping, Design Space for Snooping Protocols, Single-Level Caches with an Atomic Bus Multilevel Cache Hierarchies, Split-Transaction Bus Design, Sequential Consistency, Relaxed memory consistency models Synchronization: Mutual Exclusion, Event, and Barrier Synchronization, Algorithms for locks and barriers

MODULE III
Directory-Based Cache Coherent Multiprocessors: Directory-Based Approaches, Memory-Based Directory Protocols, Cache-Based Directory Protocols, Hierarchical Coherence
Vector Processors: Vector Programming Model, Vector Instruction Set and its advantages, Vector Arithmetic Execution, Vector Memory System Interconnection Networks: Organizational Structure, Topologies, Routing, Switch Design, Flow Control, Communication Performance

Text Books:

1. Parallel Computer Architecture: A Hardware/Software Approach by David E. Culler and Jaswinder Pal Singh with Anoop Gupta. Morgan-Kaufmann Publishers, Inc. ISBN 1-55860-343-3
2. John Hennessy and David Patterson, Computer Architecture: A Quantitative Approach, Fourth Edition, Morgan Kaufmann Publishers, 2006, ISBN: 0-12-370490-1

Reference Books:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar: Introduction to Parallel Computing, Second Edition Pearson Education 200

OE 1	EI6308	Signal Processing in Mechatronics Systems	3	0	0	3

Prerequisite:
Mathematics: Laplace and Fourier Transform Analog Electronics circuits

Course Outcomes:
After the successful completion of the course, student will be able to

1. Apply theory of Z-transform, DFT, FFT for analysis of systems
2. Apply theory of DSP and solve numerical problems and write algorithms
3. Analyze filter characteristics and design FIR filters
4. Have an in-depth knowledge of use of digital systems in real time applications

MODULE I
Discrete- Time Signals: Sequences; representation of signals on orthogonal basis; Sampling and Reconstruction of signals
Discrete systems: Z-Transform, Analysis of LSI systems, Frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, Implementation of Discrete Time Systems.

MODULE II
Frequency selective filters: Ideal filter characteristics, low pass, high pass, band pass and band stop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, all-pass filters, inverse systems, minimum phase, maximum phase and mixed phase systems. Design of FIR and IIR filters:
Design of FIR filters using windows, frequency sampling, Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations, Butterworth, Chebyshev Filters.

MODULE III
Introduction to multi-rate signal processing: Decimation, interpolation, polyphase decomposition; digital filter banks: Nyquist filters, two channel quadrature mirror filter bank and perfect reconstruction filter banks, subband coding.
Linear Prediction and Optimum Linear Filters: Random Signals, Correlation Functions, and Power Spectra, Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Properties of the Linear Prediction-Error Filters, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction

Textbooks:

1. S. K. Mitra, Digital Signal Processing: A computer-Based Approach, 3/e, TMcHl, 2006.
2. V. Oppenheim and R. W. Shafer, Discrete-Time Signal Processing, Prentice Hall India, 2/e, 2004
3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4/e, Pearson Education, 2007

References:

1. V.K. Ingle and J.G. Proakis, ―Digital signal processing with MATLAB‖, Cengage, 2008.
2. T. Bose, Digital Signal and Image Processing, John Wiley and Sons, Inc., Singapore, 2004.
3. L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, PH, 2005.
4. Antoniou, Digital Filters: Analysis, Design and Applications, Tata McH, 2003.

OE 1	EI6310	Micro Electro Mechanical Systems	3	0	0	3

Course Outcomes: At the end of the course, the student will be able to**:**

1. Understand the purpose of MEMS and their application areas.
2. Choose appropriate microfabrication technology for a specific application.
3. Choose appropriate nanofabrication technology for a specific application.
4. Select one or more suitable MEMS integration and packaging approaches for a given application.

Module-I:

Intrinsic Characteristics of MEMS: Miniaturization, Microelectronics Integration, Mass Fabrication with Precision, Microelectronics Fabrication Process, Silicon based MEMS processes.

Electrostatic Sensing and Actuation: Introduction to Electrostatic Sensors and Actuators, Parallel-Plate Capacitors, Applications of Parallel Plate Capacitors, Thermal Sensing and Actuation: Introduction, Sensors and Actuators Based on Thermal Expansion, Thermal Couples, Thermal Resistors, Applications. Magnetic Actuation.

Module-II:

Piezoresistive Sensors: Piezoresistive Sensor Materials, Stress Analysis of Mechanical Elements, Applications of Piezoresistive Sensors. Piezoelectric Sensing and Actuation: Introduction, Properties of Piezoelectric Materials, Applications.

Bulk Micromachining and Silicon Anisotropic Etching: Introduction, Anisotropic Wet Etching, Dry Etching of Silicon-Plasma Etching, Deep Reactive Ion Etching (DRIE), Isotropic Wet Etching, Gas-Phase Etchants, Native Oxide, Wafer Bonding.

Surface Micromachining: Basic Surface Micromachining Processes, Structural and Sacrificial Materials, Acceleration of Sacrificial Etch, Stiction and Anti-Stiction Methods, Assembly of 3D MEMS, Foundry Process.

Module-III:

Optical MEMS: Passive MEMS Optical Components-Lenses, Mirrors, Actuators for Active Optical MEMS Actuators for Small Out-of-Plane Translation, Actuators for Large In Plane Translation Motion, Actuators for Out-of-Plane Rotation.

Polymer MEMS: Introduction, Polymers in MEMS- Polyimide, SU-8, Liquid Crystal Polymer (LCP), PDMS, PMMA.

Text Books

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Stephen D Senturia, Microsystem Design, Springer Publication, 2000.

Reference Books

1. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture, TMH, New Delhi, 2002.

OE 1	IP6302	Universally Accessible Built Environments	3	0	0	3

Module I

Meanings and definitions of accessibility and universal accessibility; Accessibility challenges for different groups and communities; Freedom and universal accessibility; Acts, rules and guidelines on universal accessibility; Universal accessibility standards; Harmonious guidelines

Module II

Challenges of building accessible build environments and infrastructure in settlements; Accessibility audits for public spaces, buildings, infrastructures and facilities. Acts, rules and guidelines on universal accessibility; Persons with disabilities acts and policies in India; Links between planning and universal accessibility; Development plans and universal accessibility

Module III

Universal accessibility standards; Harmonious guidelines; Persons with disabilities acts and policies in India; Links between planning and universal accessibility; Development plans and universal accessibility. Understanding efforts of government in providing accessible build environments; Accessible India Campaign, other schemes and programmes of governments and other stakeholders.

Text/ Reference Books –

1. *Helen P., Jenny D., Tanja W., David S., Leonardo S., Andrew L., Christopher P. (2016) Universal Design 2016: Learning from the Past, Designing for the Future, IOS Press Ebooks.*
2. *Indian Building Congress (2012) Guidelines for Design of Universally Accessible Built Environment, Indian Building Congress, New Delhi.*
3. *Government of India (2016) Harmonized Guidelines and Space Standards for BarrierFree Built Environment for persons with Disability and Elderly Persons, Ministry of Urban Development, New Delhi.*
4. *Hamraie A. (2017) Building Access: Universal Design and the Politics of Disability, University of Minnesota Press, Minneapolis, Minnesota.*

Course Outcome: After successful completion of the course, student will be able to –

1. Understand about accessibility and universal accessibility, issues and challenges pertaining to accessibility for different communities and groups of people.
2. Learn about urban planning and universal accessibility relation and link.
3. Sensitize stakeholders regarding the various accessibility needs and provisions for diverse population.
4. Suggest and recommend specific built environment elements and design solutions along with their accessibility attributes and specifications.

CO-PO Mapping

	PO 1 Engineering Knowledge	**PO 2** Problem Analysis	**PO 3** Design/ Development of Solutions	**PO 4** Conduct investigations of complex problems	**PO 5** Modern Tool Usage	**PO 6** The Engineer and Society	**PO 7** Environment and Sustainability	**PO 8** Ethics	**PO 9** Individual and Team Work	**PO 10** Communication	**PO 11** Project Management and Finance	**PO 12** Life-long Learning
CO 1	H	H	A	L	X	H	H	X	L	H	X	H
CO 2	H	H	A	A	A	H	H	X	L	A	X	H
CO 3	H	H	H	H	A	H	H	A	A	H	H	H
CO 4	H	H	H	H	H	H	H	A	A	H	H	H

CO-PSO Mapping

	PSO 1 Ability to co-relate the multi- disciplinary aspects, pros and cons of urban and regional planning and development around the world	**PSO 2** Establish the databank for the respective towns and cities, guide urban regional development, ensuring sustainability in built and natural environment	**PSO 3** Effective communication & ability to develop leadership skills for making pathways in tackling hurdles of development
CO 1	H	H	L
CO 2	H	H	L
CO 3	H	H	H
CO 4	H	H	H

H = High, A = Average, L = Low, X = Not Co-related

OE 1	IP6304	Environment Impact Analysis	3	0	0	3

Course Objectives

The objective of this course is:

1. To impart knowledge on different concepts of Environmental Impact Assessment.
2. To know procedures of risk assessment
3. To learn the EIA methodologies and the criterion for selection of EIA methods.
4. To pre-requisites for ISO 14001 certification
5. To know the procedures for environmental clearances and audit
6. To appreciate the importance of stakeholder participation in EIA

MODULE- I

Introduction (Preliminary Assessment): Overview and Introduction to the Course, The Environmental Impact Assessment Process, Basic Steps in EIA Process, EIA Notifications of MoEF, Project Screening and scoping for EIA, Initial Environmental Examination, public participation in environmental decision making. Prediction and Assessment of Impacts on the Air Environment: Air Pollutants Emission, Ambient Air Quality and Standards, Emission Inventories, Meteorological Data, Mass Balances, Dispersion Models, Pollutant Emissions Minimization - Case Study

MODULE- II

Prediction and Assessment of Impacts on the Surface Water Environment: Quality Impacts, Quantity Impacts, Water Quality Index, Mass Balances, Quantitative Modeling, Water Conservation - Case Study. Prediction and Assessment of Impacts on the Groundwater Environment: Hydrogeological Information, Vulnerability Mapping, Subsurface Transport and Fate.

MODULE- III

Prediction and Assessment of Impacts on the Noise Environment: Terminology, Noise Propagation from Point and Line Sources, Mitigation Measures - Case Study 4. Biological Impact Prediction and Assessment: Identifications, Related laws, Biological indices & Mitigation measures 4 6. Prediction and Assessment of Impacts on the Socioeconomic Environment: Selection of Factors, Risk and Health, Socioeconomic Gains versus Biophysical Losses. Prediction and Assessment of Impacts on the Land Environment: Soil & Geological properties, Universal Soil Loss equation, mitigation measures, Risk Assessment: Hazard Identification, Effect Assessment, Risk characterization, Risk Reduction, Environmental audit. Case studies of EIA.

Text/Reference Books:

1. Jain R.K., Urban, L.V. and Stacey, G.S., "Environmental Impact Analysis", Van Nostrand Reinhold. 2003
2. Weathern, P., "Environmental Impact Assessment – Theory and Practice", Unwin Hyman, London. 1982 3.
3. Canter, L.W., "Environmental Impact Assessment", McGraw Hill. 2006
4. Charles, H., "Environmental Impact Assessment", CRC Press. 2011
5. Morris, Peter and Riki, "Methods of Environmental Impact Assessment", Spon Press, London.

Course Outcomes: Upon successful completion of this course, the students will be able to:

CO1: Prepare EMP, EIS, and EIA report
CO2: Identify the risks and impacts of a project
CO3: Selection of an appropriate EIA methodology
CO4: Evaluation the EIA report
CO5: Estimate the cost benefit ratio of a project
CO6: Know the role of stakeholder and public hearing in the preparation of EIA

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	H	M	H	M	M	M	L	M	M	L	H
CO2	L	M	H	H	M	M	H	L	L	L	L	H
CO3	L	M	M	M	L	L	M	L	L	L	M	H
CO4	M	L	M	M	L	H	M	L	L	M	M	H
CO5	H	M	M	M	H	M	H	L	L	L	L	H
CO6	L	L	L	L	M	H	H	M	M	H	M	H

OE 1	IP6306	Geotechniques for Waste Materials	3	0	0	3

COURSE OBJECTIVE

CO1 To know the sources and effect of Surface and Sub-surface contamination and to explain transport of underground contamination.
CO2 To explain and design Landfill system and analyze its stability.
CO3 To design Ash containment system and understand the aspect of Sustainable waste management.
CO4 To ascertain the construction and planning of embankment system, vertical barrier system and cutoff walls.
CO5 To apply remediation techniques for contaminated site and describe use of geosynthetics in landfills.
CO6 To explain engineering properties of waste materials and to describe soil erosion-its causes and measures.

Module I

Surface & subsurface contamination, biological & chemical contamination sources & effect of subsurface contamination, Fate & transport of underground contamination, advection, dispersion, diffusion, sorption, vertilization, chemical reaction, biodegradation radioactive decay. Geo-environmental soils characterization & remediation methods.

Module II

Contaminants of solid waste in landfills, characteristics of solid wastes, types of landfills, site selection, shape of size of landfills, liners, covers and Leachate collection, waste containment principles, Types of barrier materials, planning & design aspects related to waste disposal. Land fill in ash ponds, infilling ponds & in rocks. Stability of landfills, sustainable waste management. Monitoring surface contamination, stabilization & modification of waste. Case studies in waste handling, soil-waste interaction.

Module III

Contaminable of slurry waste; Slurry transported wastes, slurry ponds, operation embankment construction & planning, design aspects, environmental impact & control. Vertical barriers system &cutoff walls, slurry trench cutoff, backfill design & potential defects, use of bentonite & cement in slurry. Constructional features, use of geosynsthetics in landfills, barriers &cutoff, installation of soil mixed wall barrier by deep soil mixing.
Environmental monitoring around landfills, detection, control & remediation of subsurface contamination; engineering properties & geotechnical reuse of waste materials. Demolition waste dumps, regulations. Soil erosion and land conservation; causes of soil erosion, factors contributory to erosion, erosion control measures.

Text/Reference Book:

1. Geoenvironmental Engineering- Principles and Applications: L.N. Reddy & H.F. Inyang, Marcel Dekkar (2004)
2. Geotechnical Practice for Waste Disposal: D.E. Daniel Chapman and Hall, London (1993)
3. Construction and Monitoring of Landfills: A. Bagchi, John Wiley and Pone N.Y., (1994)
4. Geotechnical Engineering (Chapter 09): D.P. Coduto, Pearson Education Asia, (2002)
5. Foundation Engineering Handbook (Chapter 20): H.Y. Fang, CBS Publishers (2004)

COURSE OUTCOME

CO1	Understand the sources and effect of Surface and Sub-surface contamination and understanding the transport of underground contamination.
CO2	Design Landfill system along with stability analysis.
CO3	Design Ash containment system and understand the aspect of Sustainable waste management.
CO4	Ascertain the construction and planning of embankment system, vertical barrier system and cutoff walls.
CO5	Apply remediation techniques for contaminated site and describe use of geosynthetics in landfills.
CO6	Explain engineering properties of waste materials and to describe soil erosion-its causes and measures.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2	PSO3
CO1	M	M	H	H	H	H	H			L	L	H	L		L
CO2	H	H	H	H	H	H	H			H	M	H	M		M
CO3	H	H	H	H	H	H	H			M	M	H	H		M
CO4	H	H	M	H	H	H	H				M	H	H		M
CO5	M	H	H	H	H	H	H				M	H	H		M
CO6	L	H	H	H	H	H	H			H	M	H	H		M

OE 1	IP6308	Project Planning and Management	3	0	0	3

Course Objectives:

1. Explore the appropriate methods to initiate, plan, execute, and control the projects.
2. Prepare tender document for bidding process.
3. Plan and schedule of project with cost optimisation.
4. Solve problems of resource allocation and leveling using network diagrams
5. Design the site lay out for execution of a project and Apply the safety measures in different types of construction sites.
6. Complete understanding of the Labour Laws and Acts

Module-I

Introduction: Definition, Objective, functions and scope of construction management; Resources for Construction, Types of Construction, stages in construction, scientific methods of management; construction team. Construction Contracts and Specifications: Types of construction contracts; contract documents; specifications; general and special conditions of contract; contract management; arbitration and settlement. Construction Planning: Construction Planning methodology, Stages of planning: -Pre-tender planning; contract planning; planning and scheduling construction jobs by bar charts; Limitations of Bar Charts. Preparation of Man, Machine, Material and Money schedule.

Module-II

Network Techniques in Construction Management: Necessity of Network Technique in Construction planning and Management. Types of Network technique. Difference between PERT & CPM. Elements of Network: -Event, Activity, Dummy. Network Rules, Methods of Numbering the Events. Work Breakdown Structure. PERT- Time Computations: - earliest Expected Time (T E), Latest Allowable Occurrence Time (T L). Combined Tabular computations for T E and T L. PERT-Network Analysis: -Slak, Critical path. CPM- Network Analysis: Activity Expected Time (T E), Latest Allowable Occurrence Time (T L). Combined Tabular computations for T E and T L. Float, Critical activity and critical path. Allocation of resources. Computer software for network analysis. Time Cost Optimization: Direct cost, indirect cost, total cost; purpose, stages and methods of cost control techniques of time cost optimization; examples and case studies.

Module-III

Site Lay-Out: Principles governing site lay out; factors affecting site lay out; preparation of site lay out. Supervision, Inspection and Quality Control: Supervisor's responsibilities; keeping records; control of field activities handling disputes and work stoppages; storage and protection of construction materials and equipment; testing and quality control. Purpose of inspection: Inspection of various components of construction; reports and records; statistical quality control. Safety in Construction: Safety: importance of safety, accident-prone situations at construction site i.e, safety measures for excavation, drilling/blasting, scaffolding/formwork, hoisting & erection demolition and hot bituminous work. Fire Safety: Safety record of construction industry, safety campaign.

Labour Laws and Acts: Wages of construction Labours, Trade unions connected with the Construction Industries, Trade union Act-1926. Labour Welfare Fund Act-1965, Payment of Wages Act, Minimum Wage Act-1948, Contract Labour act. Project Management: Feasibility study; project reports; progress reports; monitoring and controlling project activities.

Text/Reference Books:

1. Challahan, M.T., Construction Project Scheduling.
2. Srinath, L.S. PERT and CPM-Concepts and Applications.
3. Austen: Managing Construction Projects, A guide to Processes & ProceduresInternational Labour office, Geneva
4. Douglas and Manager: Construction Management, Prentice Hall

Course Outcomes(COs):

CO1: Able to explore the appropriate methods to initiate, plan, execute, and control the projects.
CO2: Able to Prepare tender document for bidding process.
CO3: Able to Plan and schedule of project with cost optimisation.
CO4: Able to Solve problems of resource allocation and leveling using network diagrams
CO5: Able to Design the site lay out for execution of a project and Apply the safety measures in different types of construction sites.
CO6: Able to understanding of the Labour Laws and Acts

Mapping of Cos with Program Outcomes(POs) and Program Specific Outcomes(PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
CO1	H	L		H	H				L		M	M	H	H	
CO2		M								L		M			
CO3		M										M			
CO4		M		M											
CO5		M			M		L		L	M	L		M	L	
CO6			L			H		L							M

OE 1	MS6302	Production Planning and Control	3	0	0	3

Module - I
Generalised model of a production system, Different kinds of production systems, mass, batchjob and cellular production
Layout: Optimisation in Product and Process layout

Module - II
Demand forecasting: Moving Average and Exponential Smoothing methods, Multiple regression method, Error in forecasting
Overview of production systems; Product Decisions: Decisions in the life cycle of a production system, Evaluation of investments in new product and services, Process Decisions: Process selection, Process analysis, Capacity planning, Line balancing
Scheduling, Comparison of dispatch rules, Johnson rule

Module - III
Inventory control: EOQ and EBQ, Backordering, Determination of safety stock, P and Q System,
Material Requirements Planning and Lot Sizing. Just-In-Time Production

Books:
1. Manufacturing Planning and Control, Vollman, Berry, Whybark & Jacobs, TMH
2. Production Planning and Inventory Control, Narasimhan S L, Mcleavey D W, Billington P J, PHI
3. D.D. Bedworth and J.E.Bailey (1983), Integrated Production Control System Management, Analysis and Design, John Wiley
4. E.G. Coffman (1976), Computer and Jobshop Scheduling Theory, Wiley

OE 1	MS6304	Design of Experiment	3	0	0	3

Module - I
Introduction to Designed Experiments: Strategy of experimentation, Typical applications, Basic principles and guidelines for designing experiments, Basic statistical concepts: Descriptive Statistics, Sampling and Sampling Distributions, Tests of Hypotheses,

Module - II
Single factor experiments with Fixed Effects: ANOVA, Model Adequacy Tests, Orthogonal Contrasts, Experiments with Blocking Factors: Randomised Complete and Incomplete Block Designs, Latin Squares Design , Factorial Experiments: 22,, 32, and 2k Designs, Blocking and Confounding, and Fractional Factorial Designs , Linear Regression Models: Estimation of Parameters, Tests of Hypothesis, Regression Model Diagnostics.

Module - III
Response Surface Design: Method of Steepest Ascent, Second-Order Response Surface, Experimental Designs, Computer Models, Mixture Experiments, Evolutionary Operations, Advanced Design of Experiments: Random Effects Models, Analysis of Covariance, Non-Normal Response, and Taguchi Methods.

Recommended Books:
1. Design and Analysis of Experiments, D. C. Montgomery, John Wiley & Sons, Wiley Student Edition, International Student Version, 7th Edition.
2. Experimental Design: From User Studies to Psychophysics, D. W. Cunningham and C. Wallraven, CRC Press.
3. Design of Experiments: An Introduction Based on Linear Models, M. Morris, Chapman & Hall/CRC Texts in Statistical Science, First Edition.
4. Experiments: Planning, Analysis, and Optimization C. F. J. Wu and M. S. Hamada, Wiley Series in Probability and Statistics, Wiley.
5. Statistics for Experimenters: Design, Innovation, and Discovery, G. E. P. Box, J. S. Hunter, and W. G. Hunter, Wiley, 2nd Edition.
6. Practical Guide to Designed Experiments: A Unified Approach, P. D. Funkenbusch, CRC Press.
7. Statistical Design and Analysis of Experiments, with Applications to Engineering and Science, R. L. Mason, R. F. Gunst, and J. L. Hess, Wiley Interscience, Second Edition.
8. Design and Analysis of Experiments A. M. Dean and D. Voss, Springer Texts in Statistics, Second Edition.
9. The Theory of the Design of Experiments, D. R. Cox and N. Reid, Chapman and Hall/CRC. 10. Statistical Design and Analysis of Experiments, P. W. M. John, (Classics in Applied Mathematics No 22), Society for Industrial and Applied Mathematics.

OE 1	MS6306	Total Quality Management and Six Sigma	3	0	0	3

Module - I

Introduction – Evolution of quality, Definition, Concept and Features of TQM, Eight building blocks of TQM, TQM thinkers and Thought – Juran Trilogy, PDSA cycle, 5S, Kaizen, Crosby's theory on Quality Management.

Module - II

TQM tools- Benchmarking: Definition, concepts, benefits, elements, reasons for benchmarking, process of benchmarking, FMEA, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept and need. Quality Performance Excellence Award- Deming Application Award, European Quality Award, Malcolm Baldrige National Quality Award.

Module - III

Six Sigma- Features of six sigma, Goals of six sigma, DMAIC, Six Sigma implementation. Statistical Process Control- Central Tendency, The seven tools of quality, Normal curve, Control charts, Process Capability. Quality Systems- ISO 9000, ISO 9000:2000, ISO 14000, other quality systems.

Recommended Book

1. Total Quality Management, Sharma D D, Sapna Book House
2. Six Sigma Fundamentals: A Complete Guide to the System, Methods and Tools, D.H. Statmatis

Reference Books

1. Six Sigma: The Breakthrough Management Strategy Revolutionizing The World's Top Corporations, Mikel J. Harry, Richard Schroeder, Don R. Linsenmann, Richard
2. Total Quality Management, Poornima M Charantimath, Sapna Book House

OE 1	MS6308	Financial Institutions, Instruments and Markets	3	0	0	3

Course Objectives:
The objectives of this course are:
To provide a comprehensive understanding of financial institutions, instruments, and markets in the Indian context. To understand about the different types of financial institutions in India, their roles and functions, and the financial instruments they offer and to learn about financial markets in India, how they operate, and the risks and rewards of investing in them.

Module-I
Introduction to Financial Institutions, Instruments, and Markets: The role of the financial system in the economy, Types of financial institutions and their functions, Financial markets, and their role in the financial system, debt, equity, and derivatives, Characteristics and risks of different financial instruments, money market, bond market, stock market, and derivatives market, Factors that affect financial market prices .

Module-II
Types of Financial Institutions in India: Reserve Bank of India (RBI),Commercial banks, Regional rural banks, Cooperative banks, Foreign banks, Non-banking financial companies (NBFCs), Mutual funds, Insurance companies, Pension funds Types of Financial Instruments in India: Money market instruments, Debt securities, Equity securities, Derivative instruments, Foreign exchange instruments, Government securities, Corporate bonds, Initial public offerings (IPOs), Mutual funds, Derivatives Types of Financial Markets in India: Money Markets, Capital Markets, Currency Markets and Derivative Markets Financial Markets Regulation in India: Introduction to financial markets and regulation.

Module-III
The Securities and Exchange Board of India (SEBI), The Reserve Bank of India (RBI), Other regulatory bodies, Regulation of primary and secondary markets, Regulation of market participants, Regulation of financial products, Regulation of market infrastructure, Enforcement and compliance

Essential Book References:
Indian Financial System by M. Y. Khan (13th Edition) Financial Markets and Institutions by ZviBodie, Alex Kane, and Alan J. Millen (10th Edition)
Suggested Readings: Corporate Finance: Theory and Practice by Aswath Damodaran (12th Edition) Options, Futures, and Other Derivatives by John C. Hull (10th Edition)

OE 1	MS6310	Renewable Energy Systems	3	0	0	3

Module I
SOLAR ENERGY: Availability of solar energy, Measurement of sunshine, solar radiation data, estimation of average solar radiation, the black body, absorptance and emittance, Kirchoff's law.

Reflection from surfaces, Solar energy selection, selective surfaces, Construction of solar flat plate and evacuated tube collectors, Performance of solar energy collectors, Solar heating and cooling. Wind mills and wind turbine systems, Classification of wind machines: Horizontal and Vertical axis configuration. High and low solidity rotors, Elements of wind mills and wind turbine systems, Aerodynamic models, Rankine Froud Actuator disc model, Betz limit, angular momentum wake rotation theory, Aerofoil sections and their characteristics, Estimation of power output and energy production.

Module II
OCEAN THERMAL ENERGY: Ocean thermal energy sources, Ocean thermal energy power plant development, Closed and open cycles. Advantages and operating difficulties.
TIDAL and WAVE ENERGY Tidal power sources, Conventional and latest design of tidal power system, the ocean wave, Oscillating water column (Japanese) and the Dam, Atol design.
GEOTHERMAL ENERGY: Earth as source of heat energy, stored heat and renewability of earth's heat, Nature and occurrence of geo thermal field, Classification of thermal fields, Model of Hyper thermal fields & Semi thermal fields, drilling hot water measurements.
FUEL CELL ENERGY: Description, properties and operation of fuel cells, Major components & general characteristics of fuel cells, Indirect methanol fuel cell systems. Phosphoric acid fuel cell systems and molten carbonate fuel cell systems.

Module III
BIOMASS ENERGY: Types of conversion techniques for the production of solid, liquid and gaseous fuels by chemical and biochemical methods, and Biomass gasifiers- Selection of a model and size, Technical, Climatic, geographical and economic issues.

BOOKS:
1. Principles of Solar Engineering: F.Kreith&J.F.Krieder/ McGraw Hill Book Co
2. Solar Energy: Sukhatme and Nayak
3. Wind Energy Conversion Systems: L.C.Freris, Prentice Hall, Inc.
4. Non-conventional Energy Sources: G.D. Rai
5. Energy Technology: S. Rao & B.B. Parulekar

OE 1	MS6312	Design of Thermal Systems	3	0	0	3

Module I
Modeling of Thermal Systems: types of models, mathematical modeling, curve fitting, linear algebraic systems, numerical model for a system, system simulation, methods for numerical simulation;

Module II
Acceptable Design of a Thermal System: initial design, design strategies, design of systems from different application areas, additional considerations for large practical systems; Economic Considerations: calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design, application to thermal systems;

Module III
Problem Formulation for Optimization: optimization methods, optimization of thermal systems, practical aspects in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems; search methods: single-variable problem, multivariable constrained optimization, examples of thermal systems; geometric, linear, and dynamic programming and other methods for optimization, knowledge-based design and additional considerations, professional ethics.

Text Books
1. W.F. Stoecker, Design of Thermal Systems - McGraw-Hill, 1971

References
1. Y. Jaluria, Design and Optimization of Thermal Systems –CRC Press, 2007.
2. Bejan, G. Tsatsaronis, M.J. Moran, Thermal Design and Optimization - Wiley, 1996.
3. R. F. Boehm, Developments in the Design of Thermal Systems - Cambridge
University Press, 1997.
4. N. V. Suryanarayana, Design & Simulation of Thermal Systems - MGH,2002.

OE 1	MS6314	Sensors and Actuators in Industry	3	0	0	3

Course Objectives:

1. To understand basics of sensors, actuators and their operating principle.
2. To study the various sensors and actuators, applications of MEMS to disciplines beyond Electrical and Mechanical.

Course Outcomes:
Upon completion of the course, the students will be able to:
CO1: Use concepts in common methods for converting a physical parameter into an electrical quantity.
CO2: Design and develop sensors using optical methods with desired properties.
CO3: Analyse the applications of Strain gauges, strain gauge, beam force sensor, piezoelectric force sensor, load cell, torque sensor in industries
CO4: Evaluate performance characteristics of different types of actuator.

Syllabus:

Module I:
Sensor fundamentals and characteristics, Sensor Classification: Position, Direction, Displacement and Level sensors, Performance and Types, Error Analysis characteristics.
Optical Sources and Detectors: Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs. Brief overview of measurement systems, classification, characteristics and calibration of different sensors.

Module II:
Strain gauges, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors.
Hydraulic and Pneumatic Actuators: Actuators, definition, example, types, selection. Pneumatic actuator, Electro Pneumatic actuator. Hydraulic actuator, control valves, valve sizing valve selection

Module III:
Electrical actuating systems: solid-state switches, solenoids, voice coil; electric motors; DC motors, AC motors, single phase motor; 3-phase motor; induction motor; synchronous motor; stepper motors.
Piezoelectric actuator: characterization, operation, and fabrication; shape memory alloys, Linear actuators

Text Books:

1. Gregory Kovacs, “Micro machined Transducers Sourcebook”, McGraw-Hill, New York (1998).

Reference Books:

1. John G. Webster, Editor-in-chief, “Measurement, Instrumentation, and Sensors Handbook”, CRC Press (1999).

OE 1	MS6316	Robot Mechanics and Control	3	0	0	3

Course Objectives:
After completion of the course, a student should be able to:
CO1 Select appropriate sensors and actuators for a particular robot task.
CO2 Evaluate inverse and forward kinematics of robot manipulators.
CO3 Derive the equations of motion for robot manipulators and perform dynamic analyses.
CO4 Write basic programs for controlling robot manipulators using embedded systems.

Module-I
Robot Classification, Serial and Parallel Manipulators, Robot Selection and Application, Sensors and Actuators, Motion and Force Sensing, Actuation Schemes, Electric, Hydraulic, and Pneumatic.

Module-II
Robot Kinematics, Degrees of freedom and mobility, Rotation representation, Coordinate transformations, DH parameters, Matrix methods for forward and inverse kinematics analyses, Jacobian and Singularity.

Module-III
Robot Dynamics and Control, Euler-Lagrange and Newton-Euler equations of motion for robot manipulators, Inverse and forward dynamic analyses, linear control of robot manipulators, microcontroller programming.

Text Book:

Craig, J. J., Introduction to Robotics: Mechanics and Control, Pearson, 3rd Edition, 2004.

Other References and Texts:

1. Siciliano, Bruno, Khatib, Oussama, Springer Handbook of Robotics, Springer, 2016.
2. Alciatore David G & Histand Michael B, Introduction to Mechatronics and Measurement Systems, 4th Edition, Tata McGraw Hill, 2006.
3. Saha, Subir Kumar. Introduction to Robotics. Tata McGraw-Hill Education, 2014.
4. Ghosal, Ashitava. Robotics: Fundamental Concepts and Analysis, Oxford, 2006.
5. Spong, Mark W., Seth Hutchinson, and Mathukumalli Vidyasagar. Robot Modelling and Control. Vol. 3. New York: Wiley, 2006.

OE 1	BT6302	Nanobiotechnology	3	0	0	3

COURSE OBJECTIVES

- Provide basic concepts of nanotechnology.
- Impart knowledge on the synthesis and characterization of nanomaterials.
- Provide knowledge on potential applications of nano technology in various fields including nanomedicine.

COURSE OUTCOMES (COs)

After completion of the course the students will be able to

CO1: Gain knowledge on concepts of nanotechnology and nanomaterials.
CO2: Apply the knowledge to synthesize and visualize nanomaterials.
CO3: Apply the knowledge in the field of drug delivery

Module-I

Course Introduction: The Science of Nano, Nanoscale Properties (Electrical, Optical, Chemical), Size effect of Nanomaterials: size, shape, density, melting point, and specific surface area comparision of Biotechnology to Nanobiotechnology, Principles of nanobiotechnology: Approaches, Energetics, gravity and intertia, water environment, Protein nanotechnology (Protein Interactions & Nanomaterial-Cell interactions) DNA nanotechnology, Overview of natural Bionanomachines. Thymidylate synthetase, ATP synthetase, Actin and myosin, opsin

Module-II

Functional principles of Nanobiotechnology: Information driven nanoassembly, Energetics, Role of enzymes in chemical transformation, Nanotechnology by self-assembly (Bottom-Up approach) & self organisation. Nanoscale visualization techniques: Electron Microscopy, Scanning probe Microscopy (AFM, STM, XRD). Carbon nanomaterials- fullerenes, nanotubes, nanowires, Quantum Dots and Metal-based nanoparticles. Nanoporous materials (metalic, zeolite). Micro-fabrication methods (photolithography, etching). Synthesis of Nanomaterials-Sol-Gel synthesis; Microemulsions synthesis, Sonochemical assisted synthesis, Biomolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Bionics, Bioelectrical phenomenon in mammals, Potassium channels, ABC Transporters and Bactreriorhodapsin,

Module-III

Miniaturized devices in nanobiotechnology- Microfluidics, Lab-on-a-chip devices, Bio-MEMs. Nanoanalysis and nanobiosensors: different classes, molecular recognition elements, transducing elements. Bionics & Plant Nanobionics typical Examples, Drug and gene delivery by polymeric-, metallic- and peptide/DNA based nanoparticles, Nanobiotechnological applications in health, Food and environment, Hybrid materials, Nanomedicine. Nanoparticles Cytotoxicity

Recommended Books

1. Bionanotechnology, David S Goodsell , John Wiley & Sons,.
2. Nanoscale Technology in Biological Systems, Greco Ralph S,CRC Press
3. Generic Methodologies for Nanotechnology: Classification and Fabrication. In NanoscaleScience and Technology, Brydson, R. M.; Hammond, C., John Wiley & Sons, Ltd: 2005
4. Chemistry of Nanomaterials: Synthesis, properties and applications, CNR Rao et. al.
5. Fundamental Properties of Nanostructured Materials, Ed. D. Fiorani (World Scientific, Singapore
6. Nanostructured Materials and Nanotechnology -II, S. Mathur and Mrityunjay Singh, Willey

OE 1	TE6302	Polymer Composite	3	0	0	3

Course Objective: The objective of teaching advanced yarn and fabric manufacturing is to equip students with in-depth knowledge and practical skills related to the latest developments, technologies, and techniques used for composite materials.

Course outcome:

1. **Knowledge:** The students will acquire basic understanding of composite materials and raw materials used for the manufacturing.
2. Comprehension: The students will develop understanding the importance of coupling agents, interfacial adhesion, filler characteristics, fabrication techniques, and manufacturing technologies in composite materials.
3. **Analysis:** Students will learn to analyze experimental characterization methods encompassing physical and mechanical property measurements, impact, fatigue, environmental behaviors, creep, non-destructive evaluation for damage identification, and overall characterization insights.
4. Application: The students will able to apply their acquired knowledge to create new composite structures

Module I

Definition and classification of composites Reinforcing fibers-natural fibers (cellulose,jute,coir etc.), carbon, ceramic, glass, aramids, polyethylene(UHMWPE),their characteristics and manufacturing process; Matrix resins: Thermoplastic and thermosetting matrix resins, their behaviour towards mechanical and thermal stress.

Module II

Coupling agents-surface treatment of fillers and fibers, Significance of interface and interfacial adhesion in composites, Particulate fillers: Importance of particle shape and size, Rule of mixture. Fabrication techniques, Goals of Composite manufacturing process, manufacturing Technologies, Characteristics, Application and Limitations: Lay-up, Spray lay- up, Automatic Lay-up, Vacuum bagging, Compression moulding, Injection moulding, Filament winding, Pultrusion, Resin transfer moulding.

Module III

Experimental characterization of composites, Measurement of physical properties, Measurement of mechanical properties, Impact properties, Fatigue properties, Environmental properties, Creep properties, Damage identification using nondestructive evaluation techniques, general remarks on characterization.

References:

1. www.nptel.ac.in
2. Analysis and performance of fibre composites by B.D.Agarwal et al
3. Chau T, and Ko F K, eds., “Textile Structural Compostes”, Elsevier,1989.
4. Adanaur S, “Textile Structural Compostes”, in Handbbook of Industrial Textiles.ed.
5. FIBERREINFORCED COMPOSITES Materials, Manufacturing, and Design by P K Mallick