FY PG Interdisciplinary Open Course List (IOC)

Sr. No	Department	Course Name	Except
1.	Computer	• Data Structures	Except Computer Specializations
2.	Electrical	• Engineering Optimization	Except Electrical Specializations
3.	E&TC	• Broadband Communication	Except E&TC Specializations
4.	Mechanical	• Mechanics of Composite Materials	Except Mechanical Specializations
5.		• Finite Element Method	Except Mechanical Specializations
6.	Metallurgy	• Design and Selection of Materials	Except Metallurgy Specializations
7.	Manufacturing Engineering and Industrial Management	• Reliability Engineering	Open to all
8.		• Autonomous Robotics and Telecherics	Except Manufacturing Engineering and Industrial Management Specializations
9.		• Project Planning and Control	Except Manufacturing Engineering and Industrial Management Specializations
10.	Planning (Town & Country Planning)	• Design Thinking and Participatory Planning	Open to all

[IOC] Data Structures

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each
End-Sem Exam – 60 marks

Course Outcomes:

Students will be able to:

1. Apply and implement advanced data structures, such as B-trees, multi-way trees, balanced trees, heaps, priority queues, to solve computational problems
2. Analyze the time and space complexity of advanced data structures and their supported operations
3. Compare the time and space tradeoff of different advanced data structures and their common operations

Unit I: **[6 Hrs]**

Review of Basic Concepts: Abstract data types, Data structures, Algorithms, Big Oh, Small Oh, Omega and Theta notations, Solving recurrence equations, Master theorems, Generating function techniques, Constructive induction.

Unit II: **[8 Hrs]**

Advanced Search Structures for Dictionary ADT: Splay trees, Amortized analysis, 2-3 trees, 2-3- 4 trees, Red-black trees, Randomized structures, Skip lists, Treaps, Universal hash functions.

Unit III: **[6 Hrs]**

Advanced Structures for Priority Queues and Their Extensions: Binary Heap, Min Heap, Max Heap, Binomial heaps, Leftist heaps, Skewed heaps, Fibonacci heaps and its amortized analysis, Applications to minimum spanning tree algorithms

Unit IV: **[6 Hrs]**

Data Structures for Partition ADT: Weighted union and path compression, Applications to finite state automata minimization, Code optimization.

Unit V: **[6 Hrs]**

Graph Algorithms: DFS, BFS, Biconnected components, Cut vertices, Matching, Network flow; Maximum-Flow / Minimum-Cut; Ford–Fulkerson algorithm, Augmenting Path.

Unit VI: **[8 Hrs]**

Computational Geometry: Geometric data structures, Plane sweep paradigm, Concurrency, Java Threads, Critical Section Problem, Race Conditions, Re-entrant code, Synchronization; Multiple Readers/Writers Problem.

Text Books:

1. Introduction to Algorithms; 3rd Edition; by by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein; Published by PHI Learning Pvt. Ltd. ; ISBN-13: 978- 0262033848 ISBN-10: 0262033844
2. Algorithms; 4th Edition; by Robert Sedgewick and Kevin Wayne; Pearson Education, ISBN- 13: 978-0321573513

References:

1. Algorithms; by S. Dasgupta, C.H. Papadimitriou, and U. V. Vazirani; Published by Mcgraw- Hill, 2006; ISBN-13: 978-0073523408 ISBN-10: 0073523402
2. Algorithm Design; by J. Kleinberg and E. Tardos; Published by Addison-Wesley, 2006; ISBN-13: 978-0321295354 ISBN-10: 0321295358

[EE-19004] Engineering Optimization

Course Outcomes:

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

1. Explain and use the basic theoretical principles of optimization and various optimization techniques.
2. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them correctly.
3. Solve and analyze complex optimization problems in various domains.
4. Implement various optimization software tools to solve power system/ control system/ machine drive problems and develop relevant algorithms.

Syllabus Contents:

Introduction to optimization, Classical Optimization: Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with inequality constraints. Linear Programming: Simplex Method, Duality, Transportation problems. Nonlinear Programming: One dimensional minimization methods, unconstrained and constrained optimization.

Dynamic Programming: Development of dynamic programming, Principle of optimality. Practical Aspects of Optimization: Reduced basic techniques, Sensitivity of optimum solution to problem parameters, advanced optimization techniques, applications of optimization techniques to real time problems.

References:

1. R. Fletcher, "Practical Optimization", Second edition, John Wiley and Sons, New York, 1987.
2. S. S. Rao, "Engineering Optimization-Theory and practice", fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and System Analysis", New age International Publishers, Third edition, 1996.
4. Bazaraa M. S., Sherali H.D. and Shetty C. "Nonlinear Programming Theory and Algorithms", John Wiley and Sons, New York 1993.
5. Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.Durga Das Basu, "Introduction to the Constitution of India" Prentice Hall EEE, 19th/20th Edn., 2001. (Students Edn.)

(IOC) [ETC-19006] Broadband Communication

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1,T2–20markseach,End-SemesterExam–60
Credits-03

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Distinguish Cellular Communication Systems from 2G to 5G
2. Compare Optical Fiber Communication and Wireless Communication on the basis of Bandwidth, Cost, Security, and Durability requirements.
3. Understand the operating principles of Wi-Fi and Wi-MAX systems, fixed wireless systems and Quality of services in broadband.
4. Evaluate the parameters related to orbital motion and link budget for the satellite.

Syllabus Contents:

Mobile Communication: Introduction, Concepts of coverage area and dead zones, Cellular system design, Frequency reuse, Co channel and adjacent channel interference, Interference reduction techniques, Fixed and Dynamic Channel Assignment Strategies, concepts of cell splitting, Handoff Process, Factors affecting Handoff Process, Handoff Strategies, Microcell Zone concept, GSM architecture, Call Flows in GSM, Multiple access techniques.

Satellite Communication: Introduction, Kepler laws, apogee and perigee heights, Orbital equations, LEO, MEO, GEO satellites, Orbit perturbations, Satellite Sub-Systems, Solar eclipse on satellite, Sun transit outage phenomena, Doppler frequency shift, Satellite Link Budget- Flux density, EIPR and received signal power equations, Calculation of system noise temperature for satellite receiver, noise power calculation, C/N ratio calculations in clear air and rainy conditions.

Fixed Wireless Systems: Microwave links, Private unlicensed links (Spread spectrum), MMDS (Multi- channel Multi-point Distribution Service), LMDS (Local Multipoint Distribution Service).

Wi-Fi and Wi-MAX Technologies: Introduction to Wi-Fi and Wi-MAX, Principles and parameters for Wireless LAN (IEEE 802.11 standards), Operating principles for Wi-MAX (IEEE 802.16 standard), Comparison of Wi-Fi and Wi-MAX.

Optical Fiber Communication: Principles of optical fiber communication, advantages and disadvantages of optical fiber communication, Optical Spectral bands, Basic optical laws and definitions, Single-mode fiber, Graded-index fiber, Signal Degradation in optical fiber: Attenuation, Dispersion.

Quality-of-Service (QoS) in Broadband: QoS issues in broadband communication, A case study of broadband service regulations for maintaining QoS by telecom regulatory bodies such as TRAI.

References:

1. Theodore S. Rappaport, "Wireless Communications-Principles and Practice",2nd edition, PHI,2010
2. Louis E. Frenzel, "Principles of Electronic Communication Systems",3rd edition, Tata McGraw Hill, 2012
3. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition, 2002
4. Recent QoS regulations released by TRAI (available on website of TRAI).

(IOC-1)Mechanics of Composite Materials

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

The student should be able to

1. Student will be able to understand the basic concepts and difference between composite materials with conventional materials.
2. Students will be able to understand role of constituent materials in defining the average properties and response of composite materials on macroscopic level.
3. Students will be able to apply knowledge for finding failure envelopes and stress-strain plots of laminates.
4. Students will be able to develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.

Syllabus Contents:

Introduction

Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus

Basic Concepts and Characteristics

Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials

Elastic Behavior of Unidirectional Lamina

Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters

Strength of Unidirectional Lamina

Micromechanics of failure; failure mechanisms, Macromechanical strength parameters, Macromechanical failure theories, Applicability of various failure theories

Elastic Behavior of Laminate

Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates

Hygrothermal Effects

Hygrothermal effects on mechanical behavior, Hygrothermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage

Stress and Failure Analysis of Laminates

Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials

References:

1. Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering and Science", CRC Press, Boca Raton, 2003.
4. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004.
5. Mazumdar S. K., "Composaite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 2002.
6. Robert M. Jones, "*Mechanics* of Composite Materials", Taylor and Francis, Inc., 1999.

(IOC-2) Finite Element Method

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The student will be able to classify a given problem on the basis of its dimensionality as 1-D, 2-D, or 3-D, time-dependence as Static or Dynamic, Linear or Non-linear.
2. The students will be able to develop system level matrix equations from a given mathematical model of a problem following the Galerkin weighted residual method or principle of stationary potential.
3. While demonstrating the process mentioned in 2 above, he will be able to identify the primary and secondary variables of the problem and choose correct nodal degrees of freedom and develop suitable shape functions for an element, implement Gauss-Legendre scheme of numerical integration to evaluate integrals at element level, and assemble the element level equations to get the system level matrix equations. He will also be able to substitute the essential boundary conditions correctly and obtain the solution to system level matrix equations to get the values of the field variable at the global nodes.
4. The student will be able to state three sources of errors in implementing FEM and suggest remedies to minimize the same for a given problem, viz. Modelling errors, Approximation errors, and numerical errors.
5. The student will be able to obtain consistent and lumped mass matrices for axial vibration of bars and transverse vibration of beams and obtain fundamental frequency of natural vibration using the methods mentioned in the curricula.
6. The students will be able use MATLAB for implementation of FEM to obtain elongations at nodes of a bar subjected to traction and concentrated loads and prescribed boundary conditions
7. The students will be able to use commercial software like ANSYS or ABAQUS for implementation of FEM to obtain stress concentration due to a small hole in a rectangular plate subjected to traction on edges and concentrated loads at points on the edges and prescribed boundary conditions.

Syllabus Contents:

Introduction, Classification of problems – Dimensionality, time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear, etc,

Differential equation as the starting point for FEM, steps in finite element method, discretization, types of elements used, Shape functions, Linear Elements, Local and Global coordinates, Coordinate transformation and Gauss-Legendre scheme of numerical integration, Nodal degrees of freedom, Finite element formulation, variational, weighted residual and virtual work methods, 1-D and 2-D problems from Structural Mechanics – Bar and Beam problem, Plane stress and plane strain problems, Axi-symmetric problems – Axi-symmetric forces and geometry, computer implementation, higher order elements, iso-parametric formulation, Eigen-value problems, Natural axial vibration of bars and transverse vibration of beams, Methods to find eigen-values and eigen-vectors.
References: 1. Chandrupatla and Belegundu "Introduction to finite elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 2001. 2. Logan Deryl L., "A First Course in Finite Element Method", Thomson Brook/Cole, 3rd ed. 2002 3. Cook R.D. "Concepts and applications of finite element analysis" Wiley, New York, 1981. 4. Reddy J N, "Finite element Method", Tata McGraw Hill publishing Co Ltd, New Delhi, Ed. 2, 2003 5. Bathe K.J., Cliffs, N.J. "Finite Element Procedures in Engineering Analysis", Englewood. Prentice Hall, 1981.

Semester II

(IOC) Design and selection of Materials

Teaching Scheme:
Lectures:3Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

At the end of course, students will be able to

1. Design process and its relation to material selection.
2. Interpret mechanical properties of materials, and apply these material properties in the design of components.
3. Determine the mechanical properties of materials, and apply these material properties in the design system components.
4. Explain the interrelationship between design, function, materials and process.

Syllabus content:

Materials in Design, Evolution of Engineering Materials, Design process, Types of design, Design flow chart- tools and material data, Interaction between Function, Material, Shape and Process.

Revision of engineering materials and properties, Material properties interrelationship charts such as Young"s modulus-density, Strength-density, Young"s modulus-Strength, wear rate-hardness, Young"s modulus – relative cost, strength-relative cost and others.

Materials selection, selection strategy: material attributes, translation of design requirements, screening attribute limits, ranking by indices, search supporting information ,Local conditions, method of finding indices, Weighted-Properties Method, computer aided selection, structural index; Case studies: table legs, flywheel, springs, elastic hinges, seals, pressure vessels, kiln wall, passive solar heating, precision devices, bearings, heat exchangers, airframes, ship structures, engines and power generation, automobile structures.

Materials Substitution, Pugh Method, Cost–Benefit Analysis, Cost basis for selection, causes of failure in service, Specifications and quality control, Selection for static strength, toughness, stiffness, fatigue, creep, corrosion resistance, wear resistance, material databases.

Process selection, ranking processes, cost, computer-based process selection, Case studies: fan, pressure vessel, optical table, cast tables, manifold jacket, spark plug insulator.

Selection under multiple constraints, conflicting objectives, penalty-functions, exchange constants, Case studies: connecting rods, windings of high field magnets, casing of minidisk player, disk-brake calliper.

Text Books:

- Michael F. Ashby, Materials Selection in Mechanical Design, third edition, Butterworth Heinemann, 2005
- J. Charles, F.A.A. Crane, J. A.G. Furness, Selection and Use of Engineering Materials, third edition, Butterworth-Heinemann, 2006.

Reference Books:

- ASM Metals Handbook, Materials Selection and Design, Vol. 20,2010.
- Myer Kutz, Handbook of Materials Selection, John Wiley & Sons, Inc., New York, 2002, ISBN 0-471-35924-6.

(Interdisciplinary Open Course offered to other Programmes)

(IOC-19010) Reliability Engineering

Teaching Scheme
Lectures :3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

1. Understand the importance and application of reliability.
2. Use the concepts of reliability in designing and maintenance of products.
3. Simulate techno economic life which is very important for industry application.

Syllabus Contents:

- Basic Probability, concept and various distributions. Concept of Reliability and analysis of various configurations of assemblies and sub-assemblies. Series, Parallel and other grouping. System reliability. Set theory, optimal Cut Set and Tie Set, 'star-delta' method, matrix method etc. System reliability determination through 'Event Tree' analysis and Fault tree analysis.
- Usage monitoring of plant and evaluation of reliability through failure data analysis.
- Concept of loading roughness, probability in design including evaluation of safety margin. Reliability of Engineering Design; Mean, Median & K statistics for Reliability evaluation (non parametric, Short Sample).
- Monte-Carlo simulation and Techno economic life.
- Optimal allocation of component reliability to achieve maximum system reliability – various techniques and methods such as Proportional, Conditional, AGREE, ARINC etc.
- Reliability, Availability and Maintainability of equipment.
- A number of case studies done in Indian perspectives using Short Sample, nonparametric reliability.
- Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), Failure Modes, Effects and Criticality Analysis (FMECA). R.P.N., Graph theory etc. Diagnostic maintenance through ferrography, Vibration Signature, SOAP and other programme

References:

1. C. Singh and C.S. Dhillon, Engineering Reliability-New Techniques and Applications –John Wiley and Sons
2. K. C. Kapoor and L. R. Lubersome, Reliability in Engineering Design Willey Publication.
3. L. S. Srinath, Concepts in Reliability Engineering- Affiliated West Press.

(IOC) Project Planning and Control

Teaching Scheme	**Examination Scheme**
Lectures : 3 hrs/week	T1/T2/ Assignments/ Quiz -40
	End-Sem Exam- 60.

Course Outcomes:

At the end of course students will be able to :

- apply fundamental and technical knowledge of Project Planning.
- demonstrate leadership and decision making capabilities
- handle the project through project planning steps.
- analyze the projects through network techniques and handle financial aspects of project

Course Contents:

Function of Project Planning –Inter dependency relationship, Generation and screening of project ideas, project rating index, characterization of the market, demand forecasting, market planning. Financial Analysis: Estimation of cost of project and means of financing, estimates of sales and production, cost of production, working capital requirement and its financing, estimates of working results, breakeven points – projected cash flow statement, projected balance sheet. Project cash flows: Basic principles of measurement of cash flows, components of the cash flow streams – viewing a project from different points of view, definition of cash flows by financial institutions and planning commission, Forms of project organization, project planning, project control, human aspects of project management, prerequisites for successful project implementation. Project review and administrative aspects: Initial review, performance evaluation, abandonment analysis, administrative aspects of capital budgeting, evaluating the capital budgeting system of an organization. Network techniques for project management, development of project network, time estimation, determination of critical path, scheduling when resources are limited, PERT and CPM models.

References:

1. Prasanna Chandra Project Planning: Analysis, Selection, Implementation and Review, Mc Graw Hill Education, 7th Edition 2009.
2. Narendra Singh, Project Management and Control, HPH, 2003
3. John M. Nicholas and Herman Steyn, Project Management for Business and Technology: Principles and Practice, Prentice Hall India, 2012

4. Clifford F. Gray & Eric W. Larson, Project Management: The Managerial Process, Tata Mc Graw Hill, 4th edition, 2010
5. Chitkara K K, Construction Project Management, Planning, Scheduling and Control, Tata McGraw-Hill, 2nd Edition, 2010.
6. Merdith Jack R & Gopalan M.R, Project Management, Wiley India (P) Ltd. 2006
7. Harold Kerzner, Project Management A systems approach to Planning, Scheduling and Controlling, Wiley India, 10th Edition, 2009

Autonomous Robots and Telecherics

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1/T2/ Assignments/ Quiz -40

Course outcomes: The students will be able to

1. learn principles of working of autonomous robots
2. demonstrate the sensing, perception, and cognition of autonomous robots
3. understand anatomy of autonomous robots
4. Understand operation of Humanoid robot
5. Understand principles of operation of telecheric robots

Introduction to the fundamentals of mobile robotics, basic principles of locomotion, Kinematics and Mobility, Classification of mobile robots, AI for Robot Navigation.
Introduction to modern mobile robots: Swarm robots, cooperative and collaborative robots, mobile manipulators, Current challenges in mobile robotics.
Autonomous Mobile Robots – need and applications, sensing, localisation, mapping, navigation and control. The Basics of Autonomy (Motion, Vision and PID), Programming Complex Behaviors (reactive, deliberative, FSM), Robot Navigation (path planning), Robot Navigation (localization), Robot Navigation (mapping), Embedded electronics, kinematics, sensing, perception, and cognition.
Telecheric robots – Concepts of teleoperations and its classifications, Need and applications of Telecheric robots, Control Input Devices, Universal Force-Reflecting Hand Controller (FRHC), Medical telerobotics,
Humanoid Robots, Swarm Robotics, Robot Applications and Ethics.

References

1. Designing Autonomous Mobile Robots, John M Holland, Elsevier, 2004
2. Morgan Quigley , Brian Gerkey, Programming Robots with ROS, Quigley et al, O'Rielly Publishers. [Murphy 2000]
3. Autonomous Mobile Robots, Edited by Shuzhi Sam Ge, Frank L Lewis,Taylor & Francis, 2006
4. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, Introduction to Autonomous Mobile Robots", MIT Press, 2nd Edition.
5. Peter Corke, Robotics Vision and Control, Springer 2011

IOC 19013 –Design thinking and Participatory Planning

Teaching Scheme
Lectures: 3 Hrs/week

Examination Schemes
T1 andT2 - 20 Marks each,
End Sem- 60 Marks

Course Outcomes:

CO1. To familiarize students with design thinking concepts and principles as a systematic process of tackling relevant business and/or social problems.

CO2. To introduce students to the practices the methods, processes and tools of design thinking from Ideation to Go-To-Market

CO3. To expose the student with perspectives, ideas, concepts, and solutions related to the design and execution of innovation driven projects using design thinking principles for interdisciplinary problem solving.

Unit 1: Design Thinking: Background and Introduction

Historic Background of Design Thinking – American Design Science, Scandinavian Co-operative design, Need, Wicked Problems concept; Development of the viewpoints on design thinking; Inter-relation of terms like : design innovation, user centred design, participatory design, co-design, co-creation; Definitions including- Definition by Tim Brown; Design thinking as an Approach, Characteristics of Design Thinking,

Unit 2: Design Thinking Methods and Processes

Design thinking as a non-linear process; design thinking mindset; Principles of Design Thinking; Stages in design thinking Stanford school 5-Stage approach, Simon Herbert Process, 4D Process, convergent and divergent thinking, Double Diamond approach; Designing for Growth approach and applications in Interaction Design, Service design thinking **.**

Unit 4: Participatory Design and Service Design: Approach

New approaches to participation; Definitions and Origins of Service design; New approaches for interaction with citizens; how do we learn, listen and reflect through visual approaches of Drawing, video, photo, citizen mapping, VR etc, Participatory planning tools , Challenges in using participatory approaches, Ethics and participation, ethical standards and challenges

Unit 3: Co-design and Participatory Design: Introduction

Participatory planning and Design Thinking; Arnstein's ladder of Participation; Inclusive, Participatory or Opportunistic Participatory; compare the different types of participatory design: human-centred design, co-design, and user-generated design; History of co-design; conventional design process vs Co-design process; Role of End user; Mindset of Co-design

Unit 5: Co-design Tools methods and Processes

Application of Design thinking to Promote Innovation; Innovation Mindset, Developing insights into end users/ stakeholders. Introduction to design tools – Storytelling, relational mapping, Visualization, Journey Mapping , Mood boards, Probe Interviews, Mind Mapping , Brainstorming , Concept Development , Assumption Testing , Rapid Prototyping, Customer Co-creation , Learning Launch.