M.Tech Open Elective

Sr. No	Department Name	Course Name	Eligibility
1	Civil	Numerical Methods	All Students except Civil Department
2		Introduction to Design of RCC and Steel Structural Members	All Students except Civil Department
3	Computer	Advanced Data Structures	All Students except Computer Department
4	Electrical	Engineering Optimization	This is open for all students excluding Electrical
5	E&TC	Artificial Intelligence	All Students
6	Instrumentation	Smart Sensors and Systems	All Students except Instru and Mechtronic
7		Micro Controller and Its Application	All Students except E&TC and Electronics students & Compulsory for F.Y.M.Tech Production
8		Automotive Embedded Product Development	TO be Offered to M.Tech Students of E&TC, Electrical and Instrumentation
9	Mechanical	Mechanics of Composite Material	All Students except Design Engineering students
10		Hybrid and Electric Vehicle	All Students
11	Metallurgical	Powder Metallurgy	Open to all including MTech Metallurgy as ILOE Dept. elective for BTech Metallurgy.
12		Laser Materials Processing	Open to Mech & Prod. Specialization & MTech Metallurgy as ILOE, dept. elective for BTech Metallurgy.
13		NanoMaterials & NanoTechnology	Including BTech Metallurgy students as dept.elective & MTech Metallurgy as ILOE
14	Production	Reliability Engineering	All Students
15		Project Planning and Control	All Students & compulsory for F.Y.M.Tech Project Management

Numerical Methods (OEC at PG Level)

Teaching Scheme
Lectures: 3 hrs/week
Examination Scheme

T1 (20 Marks), T2 (20 Marks) ESE-60 Marks

Course Outcomes:

i) At the end of the course, students will be able to demonstrate the ability to solve numerical problems related to the mathematical models mentioned in the course content.

ii) At the end of the course the students will be able to apply partial differential equations in water and environment related problems

UNIT-1

Recapitulations of the very basic fundamentals of Calculus and Matrices, System of linear algebraic equations, Computational techniques for basic operations, , Cramer's rule, Solution of equations by Gauss elimination method, Solution of equations by Gauss Jordan method, Solution of equations by other Iterative methods, Solving the linear Algebraic Equations by Matrix Inversion Method. Solution of equations by Gauss Siedel method, Relaxation method, Application of relaxation methods when the grids are not square and partially broken, To Consider the weightage factor 'LAMDA' for broken grids. Concept of Eigen value and Eigen Vectors.

UNIT-2

Theory of Errors, Absolute Errors, Relative Errors, Linear algebraic equations, Bisection method, Newton Raphson Method, Method of False Position for finding the roots of a polynomial, Partial differential equations of higher order for solving the flow through pipes and plates in case of laminar flow. For flow through plates there are three cases, Both the plates fixed, The lower plate is Static and the upper plate is moving and in the third case both the plates move in opposite Directions.

UNIT-3

Ordinary differential equations, Taylor's series, Taylor's Method for solving the Differential Equations, Euler's method for solving the Differential Equations, Modified Euler's method for solving the Differential Equations, Picard's method for solving the Differential Equations, Runga Kutta methods (2^{nd} and 4^{th} order) for solving the Differential Equations.

UNIT-4

Detail Study of Finite Difference Methods and interpolation, Differential operators, Crank- Nicolson Method, Considering single layer and double layers for Crank- Nicolson Method. Finding the first order derivative and second order derivative by the addition of subtraction of the expanded form of Taylor's Series. Fitting polynomials, Estimating missing data, Interpolation by Lagrange's, Bessel's and Sterling's method. Initial and boundary value problems. Time integration, Solution of elliptic, parabolic and hyperbolic type equations.

UNIT-5

Finite element method, an overview of FEM, Elements and Discretizations,
Introduction to Local Matrix and Global Matrix, Solving problems and formation of Global Matrix from the Local matrices. Application of finite element in groundwater studies. Details of the flow net. Concept of Caucy's Reimann Equation. Conversion of Phi to Shi function and Shi to Phi function. Application of FEM in analyzing a flow net below the base of a Hydraulic Structure. Measurement of Seepage by the help of Finite Element Method.

UNIT-6

Artificial Neural networks, Difference between conventional methods and neural network, Benefits of ANN, Concept of Bias, Concept of Input layer and Output Layer, Solving problems by taking 'n' numbers of input data and considering more than one intermediate layers, Feed forward back propagation and recurring networks. Introduction to Fuzzy logic sets, numbers, relations, Basic fuzzy operations, Fuzzy arithmetic, theory of uncertainty and information, reasoning, interface and control, Applications of Fuzzy Logic.

References:

i)Sastry S.S. " Introductory Methods of Numerical Analysis" by PHI New Delhi

ii)Akai T.J. "Applied Numerical Methods for Engineers", John Wiley Inc. New York

iii)Press W.H., Flannery B.P., TenklskyS.A. and Vetterling W.T. "Numerical Recipes

iv)The Art of Scientific Computing", Cambridge University Press, Cambridge

v)Kosko B. "Neural Networks and Fuzzy Systems", Prentice Hall of India, New Delhi

vi)Venkataraman M.K. "Numerical methods in science and Engineering", National Publisher company

(OEC) Data Structures

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, students will demonstrate the ability 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

Syllabus Contents:

- Unit 1 (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 2 (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 3 (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 4 (6 Hrs)
  Data Structures for Partition ADT: Weighted union and path compression, Applications to finite state automata minimization, Code optimization

- Unit 5 (6 Hrs)
  Graph Algorithms: DFS, BFS, Biconnected components, Cut vertices, Matching, Network flow; Maximum-Flow / Minimum-Cut; Ford–Fulkerson algorithm, Augmenting Path

- Unit 6 (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

OEC: Engineering Optimization

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

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

A. Explain and use the basic theoretical principles of optimization and various optimization techniques.
B. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them using appropriate techniques
C. Analyze and solve complex optimization problems in engineering
D. Design optimization models and use them in solving real life problems
E. To develop and Implement optimization algorithms and use software tools to solve problems in engineering
F. Make sound recommendations based on these solutions, analysis and limitations of these models.

Syllabus Contents:

Introduction to optimization, classical optimization: single variable, multivariable optimization techniques, linear programming: simplex method, duality, transportation problems, non-linear programming: one dimensional minimization methods, unconstrained optimization, dynamic programming: development of dynamic programming, principle of optimality, practical aspects of optimization: reduced basic techniques, sensitivity of optimum solution to problem parameters, modern optimization techniques

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. Gillette, "Computer Oriented Operation Research", Mc-Graw Hill Publications.
5. Bazaraa M. S., Sherali H.D. and Shetty C. "Nonlinear Programming Theory and Algorithms", John Wiley and Sons, New York 1993.
6. Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.

Semester-I

(OEC) Artificial Intelligence

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam -60

Course Outcomes:

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

- CO1: Identify and formalize a given problem in the framework of solution by AI methods
- CO2: Ability to design Fuzzy Logic based system for engineering applications
- CO3: Understanding of major areas and challenges related to Inconsistent Information systems, Evolutionary Computing and Chaotic systems

Syllabus Contents:

Knowledge Representation: Prepositional Logic, Inference Rules in Prepositional Logic, Knowledge representation using Predicate logic, Predicate Calculus, Semantic net, Frames Inconsistent Information Systems: Basic Concepts of Rough Sets, Equivalence Class and Discernibility Relations, Lower and Upper approximations, Information Systems Framework using Rough Sets, Reducts and Core, Introduction to Rough Set Software ROSE, Rules extractions, Information Gain and applications Evolutionary Computing: Genetic algorithms, Introduction to Genetic Programming Dynamical Systems and Chaos: 1-D Maps, Chaotic orbits, Fixed Points, Chaotic attractors, Bifurcations, Fractals, Mandelbrot set, Time Series analysis Representation and Manipulation of Imprecision and Uncertainty: Type-I Fuzzy Sets, Membership Functions – Triangular, Trapezoidal, PI, T-Norm, S-Norm Operations, Fuzzy Hedges, Fuzzy Relations & Composition, Type-II Fuzzy sets introduction Engineering Adaptations of Fuzzy Systems: Fuzzy Object Class, Fuzzy Logic IC chips, Fuzzy Inference Engine, Rule based fuzzy expert systems, Fuzzy Controllers, case studies Neural Networks: Introduction to neural networks and perception, Neural net Architecture and applications Term Paper: Students in a group will prepare a review term paper on the current topics related to study units in IEEE format and present it in the classes. About 6 papers will be scheduled.

References:

- Toshinori Mankato, "Fundamentals of the New Artificial Intelligence", Springer, Second Ed
- Elaine Rich, Kevin Knight, B. Nair, "Artificial Intelligence", Tata Mc Graw-Hill, Third Ed.
- K.T. Alligood, T.D. Sauer, J.A. Yorke, "Chaos-An introduction to Dynamical Systems" Springer.
- D. K. Chaturvedi, "Soft Computing- Techniques and its Applications in Electrical Engg." Springer.
- Melanai Mitchell, "An Introduction to Genetic Algorithms (Complex Adaptive Systems)" A Bradford Book; Reprint edition ,1998.

(OEC) Smart Sensors and Systems

Teaching Scheme:

Lectures: 3 hrs/week

Examination Scheme:

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

Course Contents:

Unit 1 (06)

Basic characteristics of measuring devices: Introduction to smart sensors and emerging trends, measurement techniques, static & dynamic characteristics, Interface electronics and measurement for smart sensor systems, Sensing elements and their parasitic effects,

Unit 2 (08)

Data Acquisition for dynamic sensors: Introduction, DAQ boards, Microcontrollers and digital Signal Processors for Smart Sensor Systems, case studies

Unit 3 (06)

Positioning sensors: piezoelectric technique, smart sensing technology for measurement of force, torque Sensors, pressure, and case studies of its applications

Unit 4 (06)

Thermal sensors: functional principle of thermal sensors, Heat-transfer mechanisms, Temperature-difference-sensing elements, Smart temperature sensors and systems, Case studies of smart-sensor applications

Unit 5 (07)

Chemosensors : chemosensing using sensing techniques such as thin metal films, zinc oxide and polymeric films, silicon sensors, biosensors , optical sensors , applications : Silicon sensors: an introduction 3

Unit 6 (07)

MEMS and microsensors, construction and its applications as smart sensing devices, concept of intelligent instrumentation based on neural networks and fuzzy logics

Text books:

1. Chapman, P., "Smart Sensors", ISA Publications, 1995.

Reference Books:

1. G. Gautschi, Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
2. Krzysztof Iniewski, "Smart Sensors for Industrial Applications", CRC Press , 2013(ISBN :9781466568105) * Gerard Meijer (Editor),"Smart Sensor Systems", Willey Publications, 2008 (ISBN: 978-0-470-86691-7

(ILOE) Micro Controller and Its Application

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of course students will be able to:

1. Understanding the basic principles of Microcontroller based design and development.
2. Ability to understand and design real world applications.
3. To have a better understanding on state-of-the-artinterfacing technologies, their applications.
4. Identify problem and strategy for designing the solution using appropriate Microcontrollers.

Syllabus Contents:

- Function of Project Planning –Inter dependency relationship, Generation and screening of project ideas, project rating index
- Fundamentals of Assembly language Programming; Instruction format, Assembler, Linker
- Memories: Classification, Organization, Addressing methods.
- Introduction to Embedded Systems: 8051 family 8051 Assembly Language Programming, Instruction set- Addressing Modes-Programming Techniques; Arithmetic, Timer/Counter, I/O Port, Interrupts, Serial Communication, External memory interfacing;
- Introduction to Embedded Systems: PIC family (16Fxxx) PIC Programming: Instructions set addressing Modes-Programming Techniques; Arithmetic, Timer/Counter, I/O Port, Interrupts, Serial Communication-16Fxxx and 16Cxx series;
- A/D Converter Interface (ADC08xx series)-D/A Converter Interface (DAC08xx) series; interfacing of display and keyboard
- Applications: Programming Logic Controllers; Architecture, Components, Ladder Programming, Problem solving using PLC's –CNC machines-Robotic systems: Hydraulic actuators, stepper Motors, electrical switches.

References:

1. Prasanna Chandra, "Project Planning: Analysis, Selection, Implementation and Review", Tata McGraw Hill. (Please add references as per this format)
2. Mohammad Ali Mazidi, "The 8051 Microcontroller and Embedded System: Using Assembly and C", Pearson education, Second ed., 2006.
3. Mazidi, " PIC microcontroller & embedded system" 3rdEdition ,Pearson

ILOE Automotive Embedded Product Development

Teaching Scheme:
Lectures : 3hrs/week

Examination Scheme: TBD

Topic	Details
Automotive Embedded System Overview & Products	Major Automotive trends (e-mobility, Autonomous Driving, Comfort & Connected Cars), Vehicle EE architecture, Products
Integrated Automotive Embedded Product Development	Integration of Mechanical, Software, Hardware domains and their interdependences, Design for x Abilities (manufacturability, testability, serviceability, maintainability), Overview of Design guidelines
Processes	V model, Product Engineering Process, Automotive Spice, TS 16949, Key Performance Indicators
Process, Methods & Tools	Version Management tool: PTC, Requirements Management tool: DOORS
Product reliability and Quality	Warranty, Design Validations, Process Validations, Customer Line Return, Non Quality Expenses, First Pass Yield, Statistical tools
Product safety	ASIL levels, Safety Goals, Safety Measures, HARA, FMEDA, ISO 26262
Project Organization structures	Matrix Organization, Line responsibilities, Functional responsibility, team work, leadership etc.
Project Management	Scope management, Scheduling, Cost, Monitoring & Tracking, Engineering Change Management, Milestones
Assignment	Develop project Organization, define roles & responsibilities, scheduling, budgeting for a project

Reference Books:

- Online resources
- Reference manuals from Hella-India

(ILE-2)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:

Unit 1. 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

Unit 2. 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

Unit 3. Elastic Behavior of Unidirectional Lamina

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

Unit 4. Strength of Unidirectional Lamina

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

Unit 5. 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

Unit 6. Hygrothermal Effects

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

Unit 7. 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.

Hybrid and Electric Vehicles

(MTech. Institute Open Elective)

Teaching Scheme:
Lectures : 3 Hrs/week

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

Unit I : Conventional automobile vehicles **[7hrs]**

Various resistances to vehicle motion. Forces and power required at wheels for various running conditions. Development of driving and braking forces at wheels. Construction and working of 4-stroke S.I. and C. I. engines. Engine characteristics – torque, brake power, brake specific fuel consumption and brake thermal efficiency. Combustion of fuel in engine and pollution due to combustion.

Unit II : Power train **[7hrs]**

Function of clutch, gear box, final drive and differential in automobile power train. Their construction and working. Effects of sprung mass and unsprung mass on vehicle performance. Braking system.

Unit III : Alternative fuels and alternative vehicles **[7hrs]**

Properties and sources of alternative fuels like CNG, LPG, alcohols, bio-diesel, bio-gas, hydrogen gas, solar energy, electricity and fuel cells, compressed air, flywheel. Possibility of their use in automobile vehicles. Storage of the fuels in vehicles. Their advantages and disadvantages as automobile fuels.

Unit IV : Electric machines **[7hrs]**

Characteristics and controls of DC machines, induction machines, permanent magnet machines and switched eluctance machines.

Unit V Architecture of electric and hybrid electric vehicles **[7hrs]**

Architecture of electric vehicles. Classification of architecture of hybrid electric vehicles based on path of energy flow, degree of hybridization and charge- sustaining. Series HEV power train. Parallel HEV power train.Series-parallel combination HEV power train. Series-Parallel 2X2 architecture. Power-split pre-transmission hybrid configuration. Parallel post-transmission hybrid configuration. Plug-In hybrid electric vehicle.

Unit VI : Power train component sizing **[6hrs]**

EV and HEV power train component sizing for required initial acceleration, maximum velocity and maximum radability. Generator sizing and battery sizing.

Text Books:

1) – The Motor Vehicle – K. Newton, W. Steeds, T.K. Garrett
2) – Internal Combustion Engines – Edward F. Obert
3) – Handbook of Air pollution from I.C. Engine, Pollutant formation and Control – Eran Sher
4) – A text book of Electrical Technology – B.L. Theraja
5) – Electric and Hybrid Vehicles: Design Fundamentals – Eqbal Husain
6) – Modern Electric, Hybrid Electric, and Fuel Cell Vehicles – Mehrdad Ehsani, Yimin Gao, Ali Emadi

(OEC/ILE) Powder Metallurgy

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

The student will be able to learn the Powder Manufacturing methods,

CO1: The student will be able to know the powder and finished PM product's characterization techniques,

CO2: The student will be able to understand the powder conditioning and consolidation methods to obtain the finished products

CO3:The student will be able to comprehend various methods of consolidation and the secondary operations performed on PM parts

CO4: The student will be able to develop awareness on manufacturing and applications of a few important P/M components: properties and their dependence on processing and microstructure.

Syllabus Contents:

Manufacture of metal powders: Conventional and modern methods, Powder characterization techniques, Powder Conditioning (mixing. blending, granulation etc.), Powder compaction: Mechanical, thermal and thermo-mechanical compacting processes, New methods of consolidation, Sintering theories, mechanisms, types, variables, Secondary operations Performed on Powder Metallurgical components, Heat treatment of PM components, Manufacturing and applications of important P/M components (Porous PM bearing, Cemented carbide tools, Electrical contact materials etc.)

Text Books:

1. Anish Upadhayaya , Gopal S. Upadhayaya, Powder Metallurgy: Science, Technology, and Materials, Universities Press, 2011.
2. Randall German, Powder Metallurgy Science, Metal Powder Industry; 2 Sub edition, 1994.
3. Randall German, Powder Metallurgy & Particulate Materials Processing, Metal Powder Industry, 2005
4. F. Thumler, R. Oberacker, An Introduction to Powder Metallurgy, Institute of Materials (Great Britain), 1993.
5. Cemented Tungsten carbide Production, properties & testing – Gopal S. Upadhayay

Reference Books:

1. Randall German, Sintering Theory and Practice, Wiley-Interscience; 1 edition, 1996.
2. ASM Handbook: Volume 7: Powder Metal Technologies and Applications, 2nd edition, 1998.
3. Claus G. Goetzel, Treatise on Powder Metallurgy, VOLUME II, III, Applied and Physical Powder Metallurgy, Interscience Publishers Inc., New York, 1950.
4. L. Sands, C. R. Shakespeare, Powder Metallurgy - practice and applications, Newnes, 1966.

ILOE	Laser Materials Processing

Teaching Scheme		Examination Scheme
Lectures: 3 hrs/week		Assignments/Quiz 1,2- 20 each
		End Sem exam – 60 marks

Industrial lasers, construction, CO_2 laser, Solid state lasers, Diode laser, Excimer laser, disc and fibre laser, Comparison of lasers, Interaction of lasers with materials, reflection, absorption, Laser beam optics and characteristics – wavelength, coherence, mode and beam diameter, polarization; effect of wavelength, temperature, surface films, angle of incidence, materials and surface roughness, Spot size, focus, lens doublets, depolarizers, collimator, metal optics, scanning systems, fiber delivery systems

Heat flow theory: one-dimensional model, stationary point source models, moving point source models, Keyhole model, models for flow and stress

Applications of lasers in industry: process, mechanism, laser requirements, variations, performance and practical solutions, capabilities, advantages and limitations. Laser cutting, Laser welding, Laser surface treatment, rapid prototyping, laser bending, laser cleaning. Process automation, online control

Laser safety, standards, safety limits, laser classification

TEXT BOOKS:

- William M. Steen, ' Laser Material Processing', Spinger International edition, ISBN: 978-81-8128-880-6, 2008

Reference book:

- Metals Handbook, ASM, Metals Pak, OH 44073
- Powell J. 'CO_2 Laser cutting', Carl Hanser Verlag, Munich
- Carlsaw H.S. and Jaeger J.C. 'Conduction of heat in solids', Oxford University Press

Open Elective **Nano-materials & Nanotechnology**

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

Quiz/Assignment –20 marks

Quiz/Assignment – 20 marks

End Sem exam – 60 marks

OBJECTIVES:

- *To introduce students to nanoscience and nanotechnology*
- *To understand basics of synthesis, properties and applications of nanomaterials.*

Unit 1 **(06)**

Definition, Length scales, Importance of Nanoscale and Technology, Top down and bottom up approaches, Properties of selected nanomaterials including carbon nanotubes (CNT), metal nanoparticles, nanoclays, nanowires, colloidal semiconductors and concept of quantum dots.

Unit 2 **(06)**

Fabrication of Nanomaterials: Synthesis and purification of CNT, synthesis of expanded graphite (EG), clay, electro-ceramics, semi-conducting and magnetic nanoparticles, Fabrication of nano-composites : Clay-rubber, Clay-polymer, CNT-metal, CNT-polymer and EG-polymer,

Unit 3 **(06)**

Characterization of Nanomaterials: Scanning Probe Microscopy, Characterization and Particle size determination by X-ray diffraction, Transmission Electron Microscope (TEM), Atomic force microscope, UV-Visible spectroscopy.

Unit 4 **(06)**

Thin Films: Production of thin films by PVD, CVD, Film formation mechanisms, Epitaxial films, their growth, structure and their relevance in semiconductors, electrical properties of thin films, magnetic thin films for memory applications and protective coatings,

Unit 5 **(06)**

Biomaterials: Introduction, Property requirements of biomaterials, Classes of biomaterials used including metals, polymers and nanocomposites, hydrogels, thin films and coatings. Degradation of materials in biological environment,

Unit 6 **(06)**

Applications in medicine, dentistry and artificial organs and implants. Applications: Applications in structural, electronics, optical, magnetic and bio-medical fields, solar cells, LED, LCD, electrically conducting polymers, batteries, fuel cells, Nano-composites, Nano-SMART materials.

REFERENCE BOOKS:

- Nanomaterials: An introduction to synthesis, properties and applications, Editor-Dieter Vollath, Wiley-CVH
- Nanoscale Materials in Chemistry, Editor: Kenneth J. Klabunde, Publisher-Wiley-Interscience.
- Encyclopedia of Nanotechnology- Hari Singh Nalwa.
- Springer Handbook of Nanotechnology - Bharat Bhusan, Springer-Verlag Publ media.
- Handbook of Semiconductor Nanostructures and Nanodevices Vol 1-5- A. A. Balandin, K. L. Wang.
- Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong.

(OEC) Reliability Engineering

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
T1/T2/ Assignments/ Quiz -40
End-Sem Exam- 60 marks

Course Outcomes:

1. Student will be able to understand the importance and application of reliability.
2. Student will be able to use the concepts of reliability in designing and maintenance of products.
3. Student will be able to 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 Relaibility-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.

(OEC) Project Planning and Control

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of course students will be able to:

1. Comprehensive fundamental and technical knowledge of Project Planning.
2. Leadership and decision making capabilities
3. Ability to handle the project through project planning steps.
4. Ability to analyze the projects through network techniques and handle financial aspects of project.

Syllabus 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,
- 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:

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