Group No.	Course Code	Course Title	Unique Code
1	20MCM11	Numerical methods for Engineering	201ME001
1	20MTP244	Cryogenics	201ME002
1	**20MTP251**	**Solar thermal technologies and applications**	201ME003
1	20MMD243	Material handling equipment design	201ME004
1	20MMD254	Design of Intelligent system	201ME005
1	20MST15	Mechanical Behaviour of thin films	201ME006
1	20MCM242	Tooling for manufacture in Automation	201ME007
1	**20CAE333**	**Design of Vibration control system**	201ME008
1	**20MEM332**	**Product Data Management**	201ME009
1	20MTE323	Material Flow Analysis	201ME010
1	20MMD14	Fracture Mechanics	201ME011
1	20MST322	Manufacturing of Electronic Components	201ME012
1	**20MSE14**	**Advanced joining Processes**	201ME013
2	**20MPM324**	**Value Engineering**	202ME001
2	**20MSE251**	**Micro Machining Processes**	202ME002
2	**20MAU244**	**Engine management systems**	202ME003
2	20MTP13	Advanced fluid mechanics	202ME004
2	20MTP323	Design and Analysis of thermal system	202ME005
2	20MTP243	Nuclear engineering in power generation	202ME006
2	20MMD253	Rotor Dynamics	202ME007
2	**20MMD242**	**Machine Learning for Mechanical Engineering**	202ME008
2	20MST252	Bio material and Technology	202ME009
2	20MTE15	Gauges and Measurements	202ME010
2	20MCM333	Virtual Instrumentation	202ME011
2	20CAE252	Applied materials Engineering	202ME012
2	**20MSE332**	**Agile manufacturing**	202ME013
2	**20MEM15**	**Managerial Economics**	202ME014
2	**20MTE321**	**Advanced moulding Techniques**	202ME015
2	**20MMD23**	**Tribology and Bearing Design**	202ME016
2	20MST253	Mechanical Methods in Engineering	202ME017

3	**20MPM321**	**Rapid prototyping**	203ME001
3	**20MEM253**	**Robust Design**	203ME002
3	**20MTP14**	**Combustion Thermodynamics**	203ME003
3	20MTP332	Non conventional Energy Resources	203ME004
3	**20MTP252**	**Modelling and Simulation of thermal system**	203ME005
3	20MMD241	Creation Engineering	203ME006
3	**20MMD251**	**Automobile system Design**	203ME007
3	**20MST244**	**Advances in Material and Processing**	203ME008
3	20MTE333	Computer control of manufacturing system	203ME009
3	20MCM321	Logistics and supply chain management	203ME010
3	20CAE241	C IM and Robotics for automation	203ME011
3	**20MSE324**	**Precision Engineering**	203ME012
3	**20MEM22**	**Human Resources Management**	203ME013
3	20MTE22	Jigs and Fixture Design	203ME014
3	20MMD12	Design of Vibration control system	203ME015

4	20MTP15	Advanced power plant cycle	204ME001
4	**20MTP331**	**Experimental methods in thermal power Engineering**	204ME002
4	20MTP321	Converting Heat and Mass transfer	204ME003
4	**20MMD332**	**Design Optimization**	204ME004
4	20MMD323	Composite material Technology	204ME005
4	**20MST333**	**Corrosion science and Technology**	204ME006
4	20MTE322	Non science and Non martial	204ME007
4	20MCM323	Reliability Engineering	204ME008
4	20CAE331	Dynamics and Mechanism Design	204ME009
4	20MSE322	Tool Design	204ME010
4	20MPD324	Advanced fluid power system	204ME011
4	20MTP333	Gas Dynamics	204ME012
4	**20MAR252**	**Drives and control system for automation**	204ME013

5	**20MPE31**	**Theory of metal forming**	205ME001
5	**20MPM13**	**Lean Manufacturing System**	205ME002
5	**20MEM252**	**Product Life Cycle Management**	205ME003
5	20MTP241	Engineering conservation and management	205ME004
5	20MTP254	Jet Propulsion and Rocketry	205ME005
5	**20MTP324**	**Phase change phenomena in fluids**	205ME006

5	20MMD321	Mechatronics system Design	205ME007
5	**20MMD331**	**Smart Material and Structures**	205ME008
5	**20MST323**	**Non- traditional machines**	205ME009
5	**20MTE251**	**Product Design technology**	205ME010
5	**20MAR251**	**Networking and IOT**	205ME011
5	20CAE243	Vehicle Aerodynamics	205ME012
5	20MSE23	Advanced processing of materials	205ME013
5	20MEM321	Industrial Marketing	205ME014
5	20MPE13	Advanced Foundry Technology	205ME015
5	20MTE331	Design for Manufacture	205ME016
5	20MCM243	Metrology and computer Aided Inspection	205ME017

6	20MTP242	Thermal power station	206ME001
6	**20MTP253**	**Computational methods in Heat transfer and fluid Flow**	206ME002
6	20MTP322	Theory of I.C Engine	206ME003
6	20MMD324	Experimental Mechanics	206ME004
6	**20MMD333**	**Design of hydraulic and pneumatic system**	206ME005
6	20MST31	Plastic procession	206ME006
6	20MTE242	Tooling for Manufacturing in Automation	206ME007
6	20MAR31	Artificial Intelligence and expert system in Automation	206ME008
6	**20CAE253**	**Design of Micro Electro Mechanical system**	206ME009
6	**20MSE253**	**Surface treatment and Finishing**	206ME010
6	**20MEM323**	**Industrial design and Ergonomics**	206ME011
6	20MPD254	Design of Experiment	206ME012
6	20MTP334	Thermal storage system	206ME013
6	20CAE321	Mechatronics System Design	206ME014

Group No	Course Code	Course Title
1	20MCM11	Numerical methods for Engineering
1	20MTP244	Cryogenics
1	**20MTP251**	**Solar thermal technologies and applications**
1	20MMD243	Material handling equipment design
1	20MMD254	Design of Intelligent system
1	20MST15	Mechanical Behaviour of thin films
1	20MCM242	Tooling for manufacture in Automation
1	**20CAE333**	**Design of Vibration control system**
1	**20MEM332**	**Product Data Management**
1	20MTE323	Material Flow Analysis
1	20MMD14	Fracture Mechanics
1	20MST322	Manufacturing of Electronic Components
1	**20MSE14**	**Advanced joining Processes**

Group no.	**1**	Subject Code	20MCM11	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**NUMERICAL METHODS FOR ENGINEERS**				

Module-1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model.
Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration. MATLAB or Sci Lab session for solving equations using Graphical method, Bisection method, False position method and Newton Raphson method.

Module-2

Roots of Polynomial-Polynomials in Engineering and Science, Muller's method, Numerical Differentiation and Numerical Integration: Newton – Cotes and Guass Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae. MATLAB or Sci Lab session for Numerical differentiation and Numerical Integration**.**

Module-3

System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, Iteration Methods. MATLAB or Sci Lab session for solving system of equations using Cramer's Rule, Gauss elimination method and Gauss-Jordan method.

Module-4

Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method. MATLAB or Sci Lab session for finding eigen values and eigen vectors of a square matrix.

Module-5

Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engineering. Orthogonality and Least Squares: Inner product, length and orthogonality, orthogonal sets. Model some simple mathematical models of physical Applications and Find the roots of polynomials in Science and Engineering problems

Course outcomes:
At the end of the course the student will be able to:

- Use the numerical methods for solving algebraic and transcendental equations which comes in mechanical engineering courses
- Demonstrate common numerical methods and how they are used to obtain approximate solutions
- Analyze and evaluate the accuracy of common numerical methods.
- Apply modern tools numerical methods to solve problems
- Write efficient code and present numerical results in an informative way.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.

(2) Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4 th Ed, 2002.

(3) M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference Books

(1) Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010

(2) David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.

(3) (3) Brian R Hunt, Ronald L Lipsman, Jonathan M Rosenberg, A Guide to MATLAB for Beginners and Experienced Users. Cambridge University Press.

Group no.	**1**	Subject Code	20MTP244	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**CRYOGENICS**				

Module-1

Introduction: Cryogenics and its applications, Cryogenic Fluids, Properties of cryogenic fluids, Properties of materials at cryogenic temperature. Gas Liquefaction and Refrigeration Systems: Basics of Refrigeration/Liquefaction, Production of low temperatures, Ideal thermodynamic cycle and Various liquefaction cycles: Linde–Hampson system, Linde Dual –Pressure System, Claude System, Kapitza System, Heylandt System and Collins System.

Module-2

Gas Separation: Basics of Gas Separation, Ideal Gas Separation System, Properties of Mixtures and the Governing Laws, Principles of Gas Separation, Rectification and Plate Calculations. **Cryocoolers:** Classification and application of Cryocooler, Recuperative Cryocoolers, Regenerative Cryocoolers, J-T Cryocooler, Stirling Cryocooler, G-M Cryocooler and Pulse Tube Cryocooler.

Module-3

Vacuum Technology: Need of Vacuum in Cryogenics, Vacuum fundamentals, Conductance and Electrical analogy, Pumping Speed and Pump down time and Vacuum Pumps.

Module-4

Instrumentation in Cryogenics: Need of Cryogenic Instrumentation, Measurement of Thermo-physical Properties and Various Sensors.

Module-5

Cryogenic Insulations: Importance of Cryogenic insulation, Types of Cryogenic insulations and application **Safety in Cryogenics** Need for Safety, basic hazards and protection from hazards.

Course outcomes:
At the end of the course the student will be able to:

- **CO1:** Understand the working principles and applications of different types of gas liquefaction and refrigeration systems.
- **CO2:** Understanding the governing laws and principles of gas separation.
- **CO3:** Study on cryocoolers and its applications.
- **CO4:** Understanding the importance of cryogenics insulations and Safety in Cryogenics.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Randall F. Barron, "Cryogenics Systems", Second Edition Oxford Univesity Press New York,Clarendon Press, Oxford 1985.
2. Timmerhaus, Flynn, "Cryogenics Process Engineering", Plenum Press, New York.
3. Pipkov, "Fundamentals of Vacuum Engineering", Meer Publication.

Reference Books

1. G.M Walker. "Cryocooler-Part 1 Fundamentals" Plenum Press, New York and London.
2. G.M Walker. "Cryocooler-Part 2" Plenum Press, New York and London.

Group no.	**1**	Subject Code	20MTP251	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**SOLAR THERMAL TECHNOLOGIES AND ITS APPLICATIONS**				

Module-1

Solar Radiation: Location on earth, celestial sphere, horizon and equatorial system, Instruments for measuring solar radiation and sunshine, description of the various angles depicting the relation between sun and earth, coordinates transformation, solar time, obliquity and declination of the sun, apparent motion of the sun, sun rise and sun set time, east west time, analysis of the direct daily solar radiation on any arbitrarily located surface.

Module-2

Flat Plate Collectors: Performance analysis, transmissivity of the cover system, overall loss coefficient and heat transfer correlations, collector efficiency factor, collector heat removal factor, effects of various parameters on the performance. Evacuated Tube Collectors Principle of working, advantages of ETC over FPC, Types of evacuated tubes. Design aspects of solar plate collectors.

Module-3

Concentrating Collectors: Types, description of cylindrical parabolic collector, orientation and tracking modes, performance analysis, parametric study of collector performance in different modes of operation, compound parabolic collector geometry, tracking requirements, parabolic dish collector.

Module-4

Thermal Energy Storage: Introduction, sensible heat storage: liquids, solids, analysis of liquid storage tank in well mixed condition and thermal stratification, analysis of packed-bed storage, latent heat storage, thermo chemical storage.

Module-5

Applications: Water heating systems (Natural and Forced), Industrial process heating system, Active and passive space heating, Solar absorption refrigeration, Power generation (Low Temperature, Medium Temperature, High Temperature), Distillation, Drying, Cooking, Solar Pond. Recent advancement in materials and systems for thermal energy storage systems.

Course outcomes:
At the end of the course the student will be able to:

- CO 1 Analyse the energy concepts on solar devices for various thermal properties.
- CO 2 Analyse the solar thermal devices for various tracking modes.
- CO 3 Evaluate the performance of various solar thermal technologies.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1.S.P. Sukhatme, J K Nayak "Solar Energy- Principles of Thermal Collection and Storage", Tata McGraw Hill Company
2.G. D. Rai., "Non- Conventinal Energy Sources", Khanna Publishers, NewDelhi

Reference Books

1. G.N. Tiwari and S. Suneja, Solar Thermal Engineering Systems, Narosa Publishers.
2. Khan, B.H., "Non-Conventional Energy Resources", Tata McGraw Hill, 2nd Edition, New Delhi.
3. Recent Advancements in Materials and Systems for Thermal Energy Storage, Dott. Andrea Frazzica, Prof. Luisa F. Cabeza, ISBN 978-3-319-96639-7

Group no.	**1**	Subject Code	20MMD243	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MATERIAL HANDLING EQUIPMENT DESIGN**				

Module-1

Introduction: Elements of Material Handling System,Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipment.

Selection of Material Handling Equipment: Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material Handling Systems; functions and parameters affecting service; packing and storage of materials.

Module-2

Conveyor Design: Introduction to apron conveyors, Pneumatic conveyors, Belt Conveyors, Screw conveyors and vibratory conveyors and theirapplications, Design of Belt conveyor-Belt selection procedure and calculation of drop energy, Idler design.

Module-3

Design of hoisting elements: Welded and roller chains -Hemp and wire ropes -Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks –crane grabs-lifting magnets -

Grabbing attachments -Design of arresting gear -Brakes: shoe, band and cone types

Module-4

Design of cranes: Hand-propelled and electrically driven E.O.T overhead Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes

Module-5

Design of Bucket Elevators: Introduction, Types of Bucket Elevator, Design of Bucket Elevator - loading and bucket arrangements, Cage elevators , shaft way, guides, counter weights.

Packaging and storage of bulk materials: Steps for design of packages, protective packaging, testing the physical characteristics of packaging, container testing, types of storage and industrial containers, Automatic guided vehicles, Automatic storage and retrieval system

Course outcomes:

At the end of the course the student will be able to:

C01	Select appropriate equipment for material handling and understand the basic roles of the different equipment.
C02	Apply appropriate techniques for improving existing material handling systems; recognize the importance of safety and applicatons of optimization techniques to material handling.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Conveyor Equipment Manufacturer's Association, "Belt conveyors for bulk materials" 6th edition,The New CEMA Book
2. Rudenko N., "Materials handling equipment ", Elnvee Publishers, 1970
3. Ishwar GMulani and Mrs.Madhu I Mulani, "Engineering Science and application design for belt conveyor", Madhu I. Mulani, 2002.
4. Spivakovsy A.O. and Dyachkov V.K., "Conveying Machines, Volumes I and II" , MIR Publishers, 1985.
5. Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 1981.
6. Boltzharol, A., "Materials Handling Handbook", The Ronald press company 1958.
7. Kulwiac R. A., 'Material Handling Hand Book', 2nd edition, JohnWilly Publication, NewYork.
8. James M. Apple, 'Material Handling System Design', John-Willlwy and Sons Publication, NewYork

Group no.	**1**	Subject Code	20MMD254	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN OF INTELLIGENT SYSTEMS**				

Module-1

Overview of Artificial Intelligence: Artificial Intelligence and its Application areas; Knowledge Representation and Search: The Predicate Calculus: The Propositional Calculus, The Predicate Calculus, Using Inference Rules to Produce Predicate Calculus Expressions, Application: A Logic-Based Financial Advisor; Structures and strategies for state space search: Introduction, Structures for state space search ,Strategies for State Space Search, Using the State Space to Represent Reasoning with the Predicate Calculus; And/Or Graphs.

Module-2

Heuristic Search: Introduction, Hill Climbing and Dynamic Programming, The Best-First Search Algorithm, Admissibility, Monotonicity and Informedness, Using Heuristics in Games, Complexity Issues.

Control and Implementation of State Space Search: Introduction, Recursion-Based Search, Production Systems, The Blackboard Architecture for Problem Solving.

Module-3

Other Knowledge Representation Techniques: Semantic Networks, Conceptual Dependencies, Scripts and Frames, Conceptual Graphs.

Knowledge Intensive Problem Solving: Overview of Expert System Technology, Rule-Based Expert Systems, Model-Based, Case Based, and Hybrid Systems

Planning: Introduction to Planning, Algorithms as State-Space Search, Planning graphs.

Module-4

Automated Reasoning: Introduction to Weak Methods in Theorem Proving, The General Problem Solver and Difference Tables, Resolution Theorem Proving;

Uncertain Knowledge and Reasoning: Introduction to Uncertainty, Inference using Full-Joint Distribution, Independence, Bayes' Rule and its use. Representing Knowledge in Uncertain Domain: Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Network, Approximate Inference in Bayesian Network

Module-5

Introduction to Learning: Forms of Learning: Supervised learning, Unsupervised Learning, Semi-Supervised and Reinforcement Learning; Parametric Models & Non-Parametric Models, Classification and Regression problems

Artificial Neural Networks: ANN Structures, Single Layer feed-forward neural networks, Multi-Layer feed-forward neural networks, Learning in multilayer networks, networks.

Artificial Intelligence Current Trends: The Science of Intelligent Systems, AI: Current Challenges and Future Directions

Course outcomes:

At the end of the course the student will be able to:

CO1. Explore various Artificial Intelligence problem solving techniques.

CO2.Identify and describe the different AI approaches such as Knowledge representation, Search strategies, learning techniques to solve uncertain imprecise, stochastic and nondeterministic nature in AI problems.

CO3. Apply the AI techniques to solve various AI problems.

CO4. Analyze and compare the relative challenges pertaining to design of Intelligent Systems

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. George F Luger, Artificial Intelligence – Structures and Strategies for Complex problem Solving, 6th Edition, Pearson Publication, 2009, ISBN-10: 0-321-54589-3, ISBN-13: 978-0-321-54589-3
2. Stuart Russel, Peter Norvig, Artificial Intelligence A Modern Approach, 3rd Edition, Pearson Publication, 2015, ISBN-13: 978-93-325-4351-5
3. Elaine Rich, Kevin Knight, Artificial Intelligence, 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709, ISBN-13: 978-0070087705
4. Grosan, Crina, Abraham, Ajith, Intelligent Systems-A Modern Approach, Springer-Verlag Berlin Heidelberg 2011, ISBN 9783642269394, 2011.

Group no.	**1**	Subject Code	20MST15	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MECHANICAL BEHAVIOUR OF THIN FILMS**				

Module-1

Vacuum components and systems: Need for vacuum, ways to achieve vacuum, determination of vacuum, dry and vapour pumps, pressure measurement gauges, conductance and other system design considerations.

Module-2

Thin film deposition techniques: Physical and chemical vapour deposition techniques including molecular beam epitaxy, laser ablation and hot wire and microwave CVD techniques. Film contamination, cosine law of deposition, conformal coverge and line of sight deposition.

Module-3

Growth of thin films: Thermodynamic and kinetic considerations of deposition of thin films by both CVD and PVD. In situ characterization of thin film deposition process**.**

Module-4

Characterization of thin films: Different methods of thickness measurements, electrical, optical, chemical and structural property determination

Module-5

Some important applications of thin films: Hard and decorative coatings, semiconductor thin films, organic thin films.

Course outcomes:
At the end of the course the student will be able to:

- Students will be in a position to understand the science of thin films.
- Understanding of vacuum technology
- Knowledge of deposition techniques.
- Understanding of characterization techniques of thin film deposition.
- Apply knowledge to practical applications.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

Materials science of thin films, M. Ohring, Academic press, 2006

2. Vacuum deposition of thin films, L. Holland, Chapman and Hall.

Reference Books

3. Glow discharge processes, B. Chapman, Wiley, New York.
4. Thin film phenomena, K. Chopra, McGraw Hill, Yew York.
5. Thin film materials: stress, defect formation and surface evolution. L. B. Freund, S. Suresh
6.Thin Film Deposition; Principles and practices by Denald L. Smith, McGraw Hill.
7. Principles of Chemical Vapor Deposition by D. M. Dolokin, M.K. Zwrow, Kluwer Academic Publisher.
8.Chemical Vapor Deposition by Pradeep George, VDM Verles Dr. Mueller E.K.

Group no.	**1**	Subject Code	20MCM242	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**TOOLING FOR MANUFACTURE IN AUTOMATION**				

Module-1

Mechanics of Metal Cutting: Introduction, measurement of cutting forces and chip thickness, force components, chip formation and primary plastic deformation, shear plane and slip line theories for continuous chip formation.
Modern Cutting Tool Materials: Material properties, HSS related materials, sintered tungsten carbide, cermets, ceramics, polycrystalline tools, tool coatings.
Cutting tools: Basic types of cutting tools, turning tools, indexable inserts, groove geometry, edge preparation, wiper geometry, insert clamping methods, tool angles, threading tools, cutters.

Module-2

Optimization: Machining cost and production rate verses cutting speed, role of computerized optimization system, economic considerations, optimization of machining system.
Tooling Requirements for CNC Machines: Tool holding systems modular and quick change tool holding system, tool holder spindle connection, cutting tool clamping systems, milling cutter driver, side lock type chuck, collet chucks, hydraulic chucks, milling chucks. Tool magazines, Automatic tool changers.

Module-3

Location and Clamping Methods: Basic principles of locating, locating methods &devices, Basic principles of clamping, clamping methods.
Fixtures: Definitions, General considerations, Machine considerations, Process considerations, Product considerations, Types of fixtures, Vise fixtures, Milling fixtures.

Module-4

Fixtures for Automation: Work holders for CNC, Fixturing in FMS: Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies, modular fixturing system: T slot based, dowel pin based, fixturing components.

Module-5

Plastics for Tooling Materials: Introduction, Commonly used plastics for tooling, Epoxy plastics tools, Construction methods, Urethane dies, Force calculation for Urethane pressure pads.

Course outcomes:
At the end of the course the student will be able to:

- Select the cutting tool according to requirements and component design.
- Design the tooling requirement and customize the same for developing complex geometry components.
- Explain basic principles of locating & clamping. Discuss General considerations in design of drill jigs.
- Design flexible fixture for automation preprocess.
- Demonstrate application of non-metal fixture.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Cyrol Donaldson, Tool Design -, Tata McGraw Hill, India.

(2) Edward G Hoffman, Fundamentals of Tool Design -, SME, USA.

(3) Joshi, P.H., Jigs & Fixtures, Second Edition, Tata McGraw-Hill, New, Delhi 2004

(4) Hiram E Grant, Jigs and Fixture Tata McGraw-Hill, New Delhi, 2003

Reference Books

(1) William E Boyes, Handbook of Jigs & Fixtures Design -, SME, USA
(2) G.R. Nagpal, Tool Engineering & Design -, Khanna publications
(3) David A.Stephenson, John S. Agapiou, Metal cutting theory and practice, Second edition CRC taylor and Francis publishers
(4) Dr. B.J. Ranganath, Metal cutting and tool design, Vikas publishing house
(5) ASTME; Die Design Hand book; McGraw Hill.

Group no.	**1**	Subject Code	20CAE333	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN OF VIBRATION CONTROL SYSTEMS**				

Module-1

Review of Mechanical Vibrations Basic concepts: free vibration of single degree of freedom Systems with and without damping, forced vibration of single DOF-systems, Natural frequency.
Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers, and Vibration dampers.

Module-2

Transient Vibration of single Degree of freedom systems: Impulse excitation, arbitrary excitation, Laplace transform formulation, Pulse excitation and rise-time, Shock response spectrum, Shock isolation.
Random Vibrations: Random phenomena, Time averaging and expected value, Frequency Response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.

Module-3

Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis.
Modal analysis &Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis.

Module-4

Vibration and Noise Control : Basics Of Noise, Introduction, amplitude, frequency, wavelength and sound pressure lavel, addition, subtraction and averaging decibel; levels, noise dose lavel, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis tracking analysis sound quality analysis. Introduction to Automotive noise sources, Engine over-all noise lavels.

Module-5

Continuous Systems: Vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams

Course outcomes:
At the end of the course the student will be able to:
CO1. Apply Newton's equation of motion and energy methods to model basic vibrating mechanical system, model undamped and damped mechanical systems and structures for free and harmonically forced vibrations.
CO2. Model single-and multi-degree of freedom for free and forced vibrations and determine response to vibration, natural frequencies and modes of vibration.
CO3. Apply the fundamentals of vibration to its measurement and analysis.
CO4. Solve realistic vibration problems in mechanical engineering design that involves application of most of the course syllabus.
CO5. Ability to design and develop vibrations and noise control systems

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. S. S. Rao, "MechanicalVibrations" , Pearson Education, 4th edition.
2. S. Graham Kelly," Fundamentals ofMechanicalVibration" -McGraw-Hill, 2000
3. Theoryof Vibration with Application, -William T. Thomson, Marie Dillon

Reference Books

1. S. Graham Kelly," Mechanical Vibrations" , Schaum' s Outlines, TataMcGraw Hill, 2007.
2. C Sujatha," Vibrations and Acoustics – Measurements and signalanalysis" , Tata McGraw Hill, 2010

Group no.	**1**	Subject Code	**20MEM332**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**PRODUCT DATA MANAGEMENT**				

Module-1

Product Data Management : Product life cycle, Complexity in Product Development, General Description of PDM Basic functionality of PDM: Information architecture, PDM System architecture, Applications used in PDM systems. Trends in PDM.

. **08HRs**

Module-2

Document Management Systems: Document management and PDM, Document life cycle, Content Management, Document management and related technologies, Document management resources on the Internet. **08HRs**

Module-3

Workflow Management in PDM: Structure Management, Engineering Change Management, Release Management, Version Management, Configuration Management.

. **08HRs**

Module-4

Creating Product Structures: Part centric approach, CAD centric approach, Product Structure configuration, Managing Product Structures,PDM Tools: Matrix One, TeamCenter, Windchill. Enovia, PDM resources on the Internet.

. **08HRs**

Module-5

PDM Implementation Case Studies: Sun Microsystems, Inc., Mentor Graphics Corporation, Ericsson Radio Systems AB, Ericsson Mobile
Communications AB, ABB Automation Technology Products, SaabTechElectronics AB. **08HRs**

Course outcomes:

At the end of the course the student will be able to:

1. Explain the concepts, tools and techniques for managing product data.
2. Analyze various processes in the product data management frameworks.
3. Evaluate risks in large and complex workflow management environments.
4. Develop product data management plans for various types of organizations.
5. Understand the PDM and ABBtechnologies.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from each module.■

Reference Books

(1)Implementing and Integrating Product Data Management and Software Configuration Management - 20 - IvicaCmkovic Ulf Asklund
- AnnitaPerssonDahlqvist - ArchtechHousePublishers.

(2)Product Data Management - Rodger Burden - Publisher: Resource Publishing- ISBN-10: 0970035225, ISBN-13: 978-0970035226 –2003.

(3)The AutoCAD Database Book – Accessing and Managing CAD Drawing Information- Galgotia Publications - ThirdEdition.

Group no.	**1**	Subject Code	20MTE323	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MATERIAL FLOW ANALYSIS**				

Module-1

Introduction: Modeling, meshing, Boundary conditions, Loads, Optimization..

Module-2

Sheet Metal Analysis I: Metal Flow Analysis, Heat analysis, Micro structure analysis, Stress analysis, Thermo mechanic processing, Heat transfer analysis.
Sheet Metal Analysis II: Residual stress analysis, Static analysis, Contact analysis, Buckling analysis, Bending analysis, Natural frequency.

Module-3

Mold Analysis: Shrinkage analysis, Warpage analysis, Flow analysis.
Die Casting Analysis I: 3D -mesh generation, Heat flow, fluid flow, Stress and Strain.

Die Casting Analysis II: Microstructure modeling, inverse modeling, die life estimation.

Module-4

Software I: Mold flow, Pro-cast; Pro-Mechanica, De-form.

Module-5

Software II: Mold flow, Pro-cast; Pro-Mechanica, De-form.

Course outcomes:
At the end of the course the student will be able to:

1. Students will be able to make analysis of material flow, shrinkage, wrappage and microstructure analysis.
2. Knowledge of Residual stress, static analysis, contact analysis, buckling analysis and bending analysis.
3. Knowledge of Die casting analysis like, mesh generation, heat flow, stress, strain and micro structure modeling.
4. Study of die life estimation.
5. Software knowledge about mold flow and pro-cast.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

1. Operating Manuals of Mold Flow, PSG-cast, PSG Mechanica, Deform.

Group no.	**1**	Subject Code	20MMD14	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**FRACTURE MECHANICS**				

Module-1

Fracture mechanics principles: Introduction and historical review, sources of micro and macro cracks. stress concentration due to elliptical hole, strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, numerical problems. The Airy stress function, complex stress function, solution to crack problems, effect of finite size, special cases, elliptical cracks, numerical problems.

Module-2

Plasticity effects, Irwin plastic zone correction, and Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, plastic constraint factor. The thickness effect, and numerical problems.

Determination of stress intensity factors and plane strain fracture toughness: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test; standard test, and specimen size requirements.

Module-3

The energy release rate, and criteria for crack growth. The crack resistance (R curve), compliance, J integral, tearing modulus and stability.

Elastic Plastic Fracture Mechanics (EPFM): Fracture beyond general yield. The crack-tip opening displacement, the use of CTOD criteria, and experimental determination of CTOD. Parameters affecting the critical CTOD, use of J integral, and limitation of J integral.

Module-4

Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness**.**

Module-5

Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, means to provide fail-safety, required information for fracture mechanics approach, mixed mode (combined) loading and design criteria.

Course outcomes:

At the end of the course the student will be able to:

C01	Develop basic fundamental understanding of the effects of crack like defects on the performance of aerospace, civil, and mechanical engineering structures.
C02	Be able to select appropriate materials for engineering structures to insure damage tolerance.
C03	Learn to employ modern numerical methods to determine critical crack sizes and fatigue crack propagation rates in engineering structures.
C04	Understand the relationship between crack tip opening displacement, SIF and ERR and application of such parameters for ductile and brittle materials.
C05	Understanding of experimental techniques to determine the critical values of parameters at crack tip.
C06	Understand and appreciate of the status of academic research in field of fracture mechanics.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbook/ Textbooks

1. David Broek, "Elementary Engineering Fracture Mechanics", Springer Netherlands,2011
2. Anderson , "Fracture Mechanics-Fundamental and Application", T.L CRC press1998.

Reference Books

1. Karen Hellan , "Introduction to fracture mechanics", McGraw Hill, 2nd Edition
2. S.A. Meguid , "Engineering fracture mechanics" Elsevier Applied Science, 1989
3. Jayatilaka, "Fracture of Engineering Brittle Materials", Applied Science Publishers, 1979
4. Rolfe and Barsom , "Fracture and Fatigue Control in Structures" , Prentice Hall, 1977
5. Knott , "Fundamentals of fracture mechanisms", Butterworths, 1973

Group no.	**1**	Subject Code	20MST322	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MANUFACTURING OF ELECTRONIC COMPONENTS**				

Module-1

Introduction: Important components of Electronic products. Types of Semiconductor materials and properties and their properties. Manufacturing ICs: The functions of Ics manufacturing of diodes. Production of a single I c component classification of Ic Architecture.

Module-2

Manufacturing of Silicon Water: fabrication of IC on silicon wafers Fabrication of IC on Silicon wafers. Diffusion doping, Ion Implantation, Rapid thermal processing- Thermal oxidation Monolithic processing, Lithography, Photolithography, Etching processes. Thin film Deposition: Physical vapour Deposition, chemical vapor deposition, Epitoxial growth, IC component interconnection, IC yield and economics.

Module-3

IC packing. Types of packaging process. Printed Circuit Boards: Typical substrate (base) Materials and selection of substrate materials, Types of PCBs. Methods of manufacturing Of PCBs.

Module-4

Electronic Assembly: General Description of Electronic Assembly detailed study of sequences of operation for through-hole and surface mount process.

Module-5

Micro Electro-Mechanical systems Introduction to micro sensors MEMS, micro machines fundamentals of Silicon micro machining- Bulk & surface micromachining. Micro stereo lithography. Micro sensors: Types & brief description and applications of Thermal and Smart sensors & MEMS Devices.

Course outcomes:
At the end of the course the student will be able to:

- Students will be able to realise intricate manufacturing techniques associated with manufacturing electronic components.
- Demonstrate fabrication techniques.
- Thorough knowledge of circuit boards.
- Knowledge of MEMS
- Ability to identify various manufacturing process.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1.: Materials and processes in manufacturing, E. Paul Degarmo, IT Black and Ronald A Kohser Wiley student Edition 2004

2. Electronics materials handbook Vol 1., Minger ML Packing ASM

Reference Books

1. RF: Semiconductor fundamentals Addisor-Wisley, Reading mass.1998.

2.: Electronic materials & processes handbook, CA Harper & RM Sampson 2nd Edition Mc GrawHill 1994. Jarger RC: introduction to Microelectronic Fabrication. Addision – Wesley 1990

3.The science and Engineering of microelectronics, Cambell , Oxford University press 2001.

Group no.	**1**	Subject Code	20MSE14	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCED JOINING PROCESSES**				

Module-1

Distortion- methods to avoid distortion. Stresses in Joint Design. Welding and Cladding of dissimilar materials, overlaying and surfacing. Advanced soldering and Brazing processes different types,
Welding of plastics. **10 Hrs**

Module-2

Electro Slag, Welding Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding and Thermit welding. Advanced soldering and Brazing processes, Welding of plastics.**10 Hrs**

Module-3

Inspection of Welds: Destructive techniques like Tensile, Bend, Nick break, Impact & Hardness. Non-Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye Penetrant, Gamma ray inspection.

Welding Symbols- Need for, Representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples.**10 Hrs**

Module-4

Welding Design - Introduction, Principles of sound welding design, Welding joint design. Welding positions, Allowable strengths of welds, under steady loads.

Quality Control in Welding - Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes
and remedies and Quality conflicts.**10 Hrs**

Module-5

Computer-Aided Welding Design- Introduction. Principles of sound welding design, Wilding joint design. Welding positions. Allowable strengths: of welds. 1D1der steady loads. Weld throat thickness. Solved and unsolved examples.**10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Introduce the various advanced welding techniques which make them interested to choose a career in the field of welding.
2. Understand the advanced welding practices in Industries and their comparative merits and demerits.
3. Select the right kind of welding techniques for joining raw materials of various thicknesses.
4. Select appropriate welding technique suitable for joining various types of metals.
5. Understand the Computer-Aided Welding Design and Computer- Aided Welding Analysis.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books

(1)**Welding Engineering Handbook** - A.W.S.

(2)**Welding Engineering** - Rossi - McGraw Hill.

(3) **Advanced Welding processes** - Nikodaco&Shansky - MIR Publications.

2	**20MPM324**	**Value Engineering**
2	**20MSE251**	**Micro Machining Processes**
2	**20MAU244**	**Engine management systems**
2	20MTP13	Advanced fluid mechanics
2	20MTP323	Design and Analysis of thermal system
2	20MTP243	Nuclear engineering in power generation
2	20MMD253	Rotor Dynamics
2	**20MMD242**	**Machine Learning for Mechanical Engineering**
2	20MST252	Bio material and Technology
2	20MTE15	Gauges and Measurements
2	20MCM333	Virtual Instrumentation
2	20CAE252	Applied materials Engineering
2	**20MSE332**	**Agile manufacturing**
2	**20MEM15**	**Managerial Economics**
2	**20MTE321**	**Advanced moulding Techniques**
2	**20MMD23**	**Tribology and Bearing Design**
2	20MST253	Mechanical Methods in Engineering

Group no.	**2**	Subject Code	20MPM324	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**VALUE ENGINEERING**				

Module-1

INTRODUCTION TO VALUE ANALYSIS: Definition of Value, Value Analysis, Value Engineering, Value management, Value Analysis versus Value Engineering, Value Analysis versus Traditional cost reduction techniques, Symptoms to apply value analysis, Coaching of Champion concept.

TYPE OF VALUES: Reasons for unnecessary cost of product, Peeling cost Onion concept, unsuspected areas responsible for higher cost, Value Analysis Zone, attractive features of value analysis. Meaning of Value, types of value & their effect in cost reduction.

08 Hrs

Module-2

FUNCTIONAL COST AND ITS EVALUATION: Meaning of Function and Functional cost, Rules for functional definition, Types of functions, primary and secondary functions using verb and Noun, Function evaluation process, Methods of function evaluation. Evaluation of function by comparison, Evaluation of Interacting functions, Evaluation of function from available data, matrix technique, MISS technique, Numerical evaluation of functional relationships and case studies.

PROBLEM SETTING & SOLVING SYSTEM: A problem solvable stated is half solved, Steps in problem setting system, Identification, Separation and Grouping of functions. Case studies.

08 Hrs

Module-3

FUNCTIONAL COST AND ITS EVALUATION: Meaning of
Function and Functional cost, Rules for functional definition, Types of functions, primary and secondary functions using verb and Noun, Function evaluation process, Methods of function evaluation. Evaluation of function by comparison, Evaluation of Interacting functions, Evaluation of function from available data, matrix technique, MISS technique, Numerical evaluation of functional relationships and case studies.

PROBLEM SETTING & SOLVING SYSTEM: A problem solvable stated is half solved, Steps in problem setting system, Identification, Separation and Grouping of functions. Case studies.
08 Hrs

Module-4

APPLICATION OF VALUE ANALYSIS: Application of value analysis in the field of Accounting, Appearance Design, Cost reduction, Engineering, Manufacturing, Management, Purchasing, Quality Control, Sales, marketing, Material Management Etc., Comparison of Approach of Value analysis & other management techniques.
08 Hrs

VALUE ENGINEERING TECHNIQUES: Restrictors or new Value Engineering Techniques, Testing, Role of techniques in Value Engineering, Applies with Case examples for each of the techniques.

ADVANCED VALUE ANALYSIS TECHNIQUES: Functional analysis system technique and case studies, Value analysis of Management practice (VAMP), steps involved in VAMP, application of VAMP to Government, University, College, Hospitals, School Problems etc., (service type problems).
08 Hrs

Module-5

Course outcomes:
At the end of the course the student will be able to:
1. To understand the concepts of value engineering, identify the advantages, applications.
2. To understand various phases of value engineering. Analyze the function, its approach and evaluation.
3. To learn queuing theory.
4. To evaluate the value engineering operation in maintenance and repair activities.
5. To create the value engineering team and discuss the value engineering case studies.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1)Techniques of Value Analysis and Engineering– Lawrence D. Miles, McGraw – Hill Book Company, 2ndEdn.

(2)Value engineering for Cost Reduction and Product Improvement – M.S. Vittal, Systems Consultancy Services Edn 1993

(3)Value Management, Value Engineering and Cost Reduction – Edward D Heller Addison Wesley Publishing Company 1971

Reference Books

(1)Value Analysis for Better Management – Warren J Ridge American Management Association Edn 1969

(2)Getting More at Less Cost (The Value Engineering Way) – G.Jagannathan Tata Mcgraw Hill Pub. Comp. Edn 1995

(3)Value Engineering – Arther E Mudge McGraw Hill Book Comp. Edn 1981

Group no.	**2**	Subject Code	20MSE251	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MICRO MACHINING PROCESSES**				

Module-1

INTRODUCTION: Introduction to Micro System design, Material properties, micro fabrication technologies. Structural behavior, sensing methods, micro scale transport – feedback systems.**10 Hrs**

Module-2

MICROMECHANICS: Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials.
10 Hrs

Module-3

BASIC MICRO – FABRICATION: Bulk Processes – Surface Processes – Sacrificial Processes and Bonding Processes – Special machining: Laser beam micro machining – Electrical Discharge Machining – Ultrasonic Machining – Electro chemical Machining,
Electron beam machining.**10 Hrs**

Module-4

MECHANICAL MICROMACHINING: Theory of micromachining
– Chip formation – Size effect in micromachining – micro turning, micro milling, micro drilling – Micromachining tool design – Precision Grinding – Partial ductile mode grinding – Ultraprecision grinding –
Binder less wheel – Free form optics.**10 Hrs**

Module-5

SEMICONDUCTORS MANUFACTURING: Basic requirements – clean room – yield model – Wafer IC manufacturing – feature micro fabrication technologies – PSM – IC industry – New Materials – Bonding and layer transfer – devices – micro fabrication industries.
10 Hrs

Course outcomes:
At the end of the course the student will be able to:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks
(1) Sami Franssila, “Introduction to Micro Fabrication”, John Wiley and sons Ltd., UK,2004, ISBN: 978-0-470-85106-7.
Reference Books
(1)Madore J, “Fundamental of Micro Fabrication”, CRC Press, 2002
(2) Mark J. Jackson, “Microfabrication and Nanomanufacturing”, CRC Press, 2006
(3) Peter Van Zant, “Microchip fabrication”, McGraw Hill, 2004

Group no.	2	Subject Code	20MAU244	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ENGINE MANAGEMENT SYSTEMS**				

Module-1

Engine Input Sensors : Coolant & Intake Temperature, Crankshaft Position, Camshaft Position, Manifold Absolute Pressure, Throttle Position, Oxygen, Air/Fuel Ratio, Knock Speed & Distance, Battery & Switches

Output Devices: Relays, Injector Sequencing & Management, Ignition Operation, Idle Air Control, EGR, EVAP, Wastegate Solenoids, Torque Converter & Speed Control, Malfunction Indicator Light

(RBT Levels: **L1, L2, L3)**

Module-2

Speed Density/Mass Air Flow Fuel Management Strategies: Key ON Mode, Crank Mode, Open & Closed Loop, Wide-Open Throttle, Adaptive Memory Cells, Cruise &Deceleration, Wide-Open Throttle, Key OFF Mode

Fuel Injection Systems: Electronic Fuel Systems, Computer Self-Diagnostic Circuits, Electronic Throttle Actuator Control Systems, Fuel Control, Fuel Supply System Control, Injection System Inspection and Maintenance.

(RBT Levels: **L1, L2, L3)**

Module-3

Engine Diagnostic Procedures: Fuel System testing, On Board Diagnostics, Monitored & Non Monitored Circuits, Diagnostic Trouble Codes

Digital Engine Control System: Open loop and close loop control system, engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.

(RBT Levels: **L1, L2, L3)**

Module-4

SI Engine Management: Feedback carburettor system, throttle body injection and multi point fuel injection system, injection system controls, advantage of electronic ignition systems, three way catalytic converter, conversion efficiency versus lambda, Layout and working of SI engine management systems like Bosch Monojetronic

Group and sequential injection techniques. Working of the fuel system components. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control.

(RBT Levels: **L1, L2, L3)**

Module-5

CI Engine Management: Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system.

Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems

Course outcomes:

At the end of the course the student will be able to:

CO1: Identify the modern automobile accessories and engine management systems.

CO2: Understand the computerized engine testing and diagnosis procedures and shall apply the concept to develop engine control systems.

CO3 :Explain the concept of various sensors and actuators and understand their working

CO4:Explain the SI and CI engine management systems, identify the key components and diagnose their working

CO5:Understand the principles and application of electronic fuel and ignition management systems in the modern automobile

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Halderman, J. & Linder, J. Automotive Fuel and Emissions Control Systems Upper Saddle River, NJ: Pearson Education 3rd Edition, 2012

(2) Halderman, J. D., Diagnosis &Troubleshooting of Automotive Electrical, Electronic, &Computer Systems, Upper Saddle River, NJ Pearson Education 6th Edition, 2011

Reference Books

(1) Robert Bosch, Diesel Engine Management, SAE Publications 3rd Edition, 2004

(2) Wiliam B. Ribbens, Understanding Automotive Electronics Newnes, Butterworth–Heinemann 5th Edition, 2001

(3) Young, Griffitns, Automobile Electrical & Electronic Equipments .,, Butterworths, London 6Th Edition (1980)

Group no.	**2**	Subject Code	20MTP13	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCED FLUID MECHANICS**				

Module-1

Introduction: Fluid Statics, Fundamental Equations-Applications of Fundamental Equations, Relative Motion of Liquids. Kinematics of Fluids- Review of basics-Velocity potential, Stream function and Vorticity. General theory of Stress and Rate of Strain Fundamental Equations – Integral form- Fundamental Equations – Integral form-Reynolds Transport Theorem-Applications of the Integral Form of Equations-Numerical.

Module-2

Mechanics of Laminar and Turbulent Flow: Introduction; Laminar and turbulent flows; viscous flow at different Reynolds number - wake frequency; laminar plane Poiseuille flow; stokes flow; flow through a concentric annulus. structure and origin of turbulent flow - Reynolds, average concept, Reynolds equation of motion; zero equation model for fully turbulent flows and other turbulence models; turbulent flow through pipes; losses in bends, valves etc; analysis of pipe network - Hard cross method.

Module-3

Exact and Approximate solutions of N-S Equations: Introduction; Parallel flow past a sphere; Oseen's approximation; hydrodynamic theory of lubrication; Hele-Shaw Flow.

Boundary Layer Theory: Introduction; Boundary layer equations; displacement and momentum thickness, shape factor; flow over a flat plate similarity transformation, integral equation for momentum and energy ; skin friction coefficient and Nusselt number; separation of boundary layer; critical Reynolds number; control of boundary layer separation.

Module-4

Flow across Normal Shock and Oblique Shock: Basic Equations Normal Shock – Prandtl-Meyer Equation, Oblique shock-Property variation – Relations and Tables-Numericals.

Module-5

Flow through a constant area duct with Friction: Flow through a constant area duct with Friction- FannoLine, Fanno Flow -Variation of Properties – Relations and Tables-Numericals. Flow through a constant area duct with Heat Transfer-Flow through a constant area duct with Heat Transfer-Rayleigh Line, Rayleigh Flow – Variation of Properties – Relations and Tables-Numericals.

Course outcomes:

At the end of the course the student will be able to:

CO1: Illustrate the basic concepts fluid flow and their governing equations
CO2: Analyse the laminar and turbulent flow problems.
CO3: Analyse one dimensional incompressible and compressible fluid flow Problems
CO4: Distinguish normal and oblique shocks and their governing Equations.
CO5: Describe the instruments and methods for flow measurements

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) **Foundations of fluid mechanics -** S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India, 2000.

(2) White F.M., Viscous Fluid Flow, 3rd edition, Tata McGraw Hill Book Company, 2011.

Reference Books

(1) Introduction to fluid dynamics - Principles of analysis & design - Stanley Middleman, Wiley, 1997.

(2) S.M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, 4th edition, New Age techno, 2010.

(3) Schlichting, H., Boundary Layer Theory, 8th edition, Springer, 2004.

Group no.	**2**	Subject Code	20MTP323	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN & ANALYSIS OF THERMAL SYSTEMS**				

Module-1

Thermal Systems: Characteristics- formulation of design problem - Steps in the design process - Modeling of thermal systems – importance - Types of models – Mathematical Modeling, Exponential forms- Method of least squares - Counter flow heat exchanger, Evaporators and Condensers, Effectiveness, NTU, Pressure drop and pumping power.

Module-2

Design of piping and pump systems:- Head loss representation ;Piping networks; Hardy – Cross method Generalized Hardy – Cross analysis; Pump testing methods; Cavitation considerations; Dimensional analysis of pumps; piping system design practice.

Module-3

Unconstrained Optimization Techniques: Univariate, Conjugate Gradient Method and Variable Metric Method. **Constrained Optimization Techniques:** Characteristics of a constrained problem; Direct Method of feasible directions; Indirect Method of interior and exterior penalty functions.

Module-4

Thermo-economic analysis and evaluation: Fundamentals of thermo-economics, Thermo-economic variables for component evaluation; thermo-economic evaluation; additional costing considerations.

Module-5

Thermo-economic optimization: Introduction; optimization of heat exchanger networks; analytical and numerical optimization techniques; design optimization for the co-generation system- a case study; thermo-economic optimization of complex systems.

Course outcomes:

At the end of the course the student will be able to:

- CO1 Formulation of design problems related to thermal Systems.
- CO2 Develop a mathematical model for a given problem.
- CO3 Solve practical problems using suitable optimization technique.
- CO4 Design of piping and pump systems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Thermal Design & Optimization - Bejan, A., et al., John Wiley, 1996.
2. Analysis & Design of Thermal Systems - Hodge, B.K., 2nd edition, Prentice Hall, 1990.
3. Design of Thermal Systems - Boehm, R.F., John Wiley, 1987.
4. Design of Thermal Systems - Stoecker, W.F., McGraw-Hill

Group no.	**2**	Subject Code	20MTP243	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**NUCLEAR ENGINEERING IN POWER GENERATION**				

Module-1

Introduction to Nuclear Physics: Motivation for nuclear energy, Nuclear model of the atom, Equivalence of mass and energy, Binding energy, Mechanism of nuclear fission and fusion, Radio activity, Half-life, Radiation interactions with matter, Cross sections, Principles of Radiation detection, Decay Heat. **Nuclear Fuel Cycle:** Uranium exploration, mining, Uranium production, Ffuel fabrication, Spent fuel handling, Reprocessing (Purex, Urex, Diamex), Pyro processing, Fuel transportation between facilities, Radioactive waste management: Types, treatment, compaction, Vitrification etc., Materials: Fuel, Structural, Coolants, Control, Moderator, Shielding.

Module-2

Types of Nuclear Reactors: Components of a nuclear reactor, Types of nuclear reactors, Pressurized Water Reactor, Boiling water Reactor, Pressurized Heavy Water Reactor, Gas Cooled reactor, Liquid Metal cooled fast breeder reactors, Gen IV Concepts.

Module-3

Thermal Power Reactors: Layout of nuclear power plant; Zoning requirements: layout in the reactor building; Material selection for components, Operating environment. Zone control, Regulating rods, Absorbers, Shutdown systems. Fuel and Fuel transfer system; Primary heat Transport System; Emergency core cooling system; Moderator system; Auxiliary System.

Module-4

Fast Power Reactors: Breeding ratio, Doubling time, Core design features - Static and Dynamic, control rod design, Shielding principles, Fuel management, and safety. Core & important design parameters, Comparison of core components, Major primary and secondary system components. Description, choice of core materials, engineering design of core, High temperature design methods. Decay heat removal system. Instrumentation & control.

Module-5

Reactor Thermal Hydraulics: Heat Transfer in Fuel, Fuel to coolant, One dimensional heat conduction with heat generation, Heat Transfer properties of water, gas, liquid metals, Correlations, Pressure drop: Single Phase, Two Phase, Instability of two phase flow, Basic Carnot, Rankine and Brayton Cycles.

Course outcomes:

At the end of the course the student will be able to:

- **CO 1:** Understand the basic physics of nuclear reactions
- **CO 2:** Basic concepts of nuclear fuel manufacturing and spent fuel handling
- **CO 3:** Classification of nuclear reactors
- **CO 4:** Understand working principle of thermal reactor
- **CO 6:** Analyse the thermal hydraulics of nuclear reactors

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Nuclear Reactor Engineering-Concepts & Principles - G. Vaidyanathan, S. Chand co., Delhi, 2013.
2. Nuclear Reactor Engineering (3rd Edition) - S. Glasstone and A.Sesonske, Von Nostrand, 1981.

Reference Books

1. Comprehensive Nuclear Materials- Rudy J.M. Konings, vol. 1-5, Elsevier Ltd, 2012
2. Nuclear Power Plant Instrumentation and Control Systems for Safety and Security-M. Yastrebenetsky, V. Kharchenko, , February 2014.
3. Fast Breeder Reactor- A.E.Walter and A.B.Reynolds, Pergamon Press, 1981
4. Fundamentals of Nuclear Reactor Physics-E. Lewis, Academic Press, 2008

Group no.	**2**	Subject Code	**20MMD253**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ROTOR DYNAMICS**				

Module-1

FluidFilmLubrication:Basictheoryoffluidfilmlubrication,derivationofgeneralizedReynoldsequations,boundaryconditions,fluid film stiffness and damping coefficients, stability and dynamic response for hydrodynamic journal bearing, and two lobe journal bearings.
Stability of Flexible shafts:
Introduction,equationofmotionofaflexibleshaftwithrigidsupport,radialelasticfrictionforces,rotary friction, friction Independent of velocity, friction dependent on frequency, different shaft stiffness constants, gyroscopic effects, nonlinear problems of large deformation applied forces, instability of rotors in magnetic field.

Module-2

Critical Speed: Dunkerley's method, Rayleigh's method, Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, simple model with one concentrated mass at the center.

Module-3

Element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions.

Module-4

Turbo rotor System Stability by Finite Element Formulation: General turbo rotor system, generalized forces and co-ordinates system, assembly element matrices, consistent mass matrix formulation, Lumped mass model, linearised model for journal bearings, system dynamic equations. Fix stability analysis, non-dimensional stability analysis, unbalance response and transient analysis.

Module-5

Blade Vibration: Centrifugal effect, Transfer matrix and finite element approaches.

Course outcomes:

At the end of the course the student will be able to:

CO1. Provides the student understanding of modeling rotating machine elements theoretically.

CO2. Upon completion of this course, students will have gained an understanding of the design, application, and reliability evaluation of bearings in rotating machinery applications.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Cameron, “Principles of Lubrication”, Longman Publishing Group, 1986
2. Bolotin , “Nonconservative problems of the Theory of elastic stability”, Macmillan, 1963
3. Peztel, Lockie , “Matrix Methods in Elasto Mechanics”, McGraw-Hill, 1963.
4. Timosenko , “Vibration Problems in Engineering”, Oxford City Press, 2011
5. Zienkiewicz, “The finite element method in engineering science”, McGraw-Hill, 1971

Group no.	**2**	Subject Code	20MMD242	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MACHINE LEARNING for Mechanical Engineering**				

Module-1

Introduction: Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Inductive Classification: The concept learning task. Concept learning as search through a hypothesis space. General-to-specific ordering of hypotheses. Finding maximally specific hypotheses. Version spaces and the candidate elimination algorithm. Learning conjunctive concepts. The importance of inductive bias - Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning.

Module-2

Ensemble Learning: Using committees of multiple hypotheses. Bagging, boosting, and DECORATE. Active learning with ensembles - Experimental Evaluation of Learning Algorithms: Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing - Computational Learning Theory: Models of learnability: learning in the limit; probably approximately correct (PAC) learning. Sample complexity: quantifying the number of examples needed to PAC learn. Computational complexity of training. Sample complexity for finite hypothesis spaces. PAC results for learning conjunctions, kDNF, and kCNF. Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis dimension.

Module-3

Rule Learning: Propositional and First-Order: Translating decision trees into rules. Heuristic rule induction using separate and conquer and information gain. First-order Hornclause induction (Inductive Logic Programming) and Foil. Learning recursive rules. Inverse resolution, Golem, and Progol - Support Vector Machines: Maximum margin linear separators. Quadratic programming solution to finding maximum margin separators. Kernels for learning non-linear functions.

Module-4

Bayesian Learning: Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logistic regression. Bayes nets and Markov nets for representing dependencies - Instance-Based Learning: Constructing explicit generalizations versus comparing to past specific examples. KNearest-neighbor algorithm. Case-based learning - Text Classification: Bag of words representation. Vector space model and cosine similarity. Relevance feedback and Rocchio algorithm. Versions of nearest neighbor and Naive Bayes for text.

Module-5

Clustering and Unsupervised Learning: Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. K-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabled data - Language Learning: Classification problems in language: word-sense disambiguation, sequence labeling. Hidden Markov models (HMM's). Veterbi algorithm for determining most-probable state sequences. Forward-backward EM algorithm for training the parameters of HMM's. Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Conditional random fields (CRF's). Probabilistic context-free grammars (PCFG). Parsing and learning with PCFGs. Lexicalized PCFGs.

Course outcomes:

At the end of the course the student will be able to:

CO1. Choose the learning techniques with this basic knowledge

CO2. Apply effectively genetic algorithms for appropriate applications.

CO3. Apply bayesian techniques and derive effectively learning rules.

CO4. Choose and differentiate Clustering & Unsupervised Learning and Language Learning

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Tom M. Mitchell , "Machine learning", McGraw Hill 1997
2. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. Rajjan Shinghal, "Pattern Recognition", Oxford Press, 2006.

Reference Books

1. Ethem Alpaydin, "Introduction to machine learning", PHI learning, 2008.
2. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning", Springer 2001.
3. .R.O. Duda, P.E. Hart and D.G. Stork, Pattern Classification, Wiley-Interscience, 2nd Edition, 2000. 3. T. Hastie, R. Tibshirani and J. Friedman, The Elements of Statistical Learning: Data Mining, Inference and Prediction, Springer, 2nd Edition, 2009

Group no.	**2**	Subject Code	20MST252	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**BIO MATERIAL AND TECHNOLOGY**				

BIO MATERIAL AND TECHNOLOGY			
Course Code	20MST252	CIE Marks	40
Teaching Hours/Week (L:P: SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Definition of Bio material, Classification of Bio materials, Comparison of properties of some common bio materials, effects of physiological fluid on properties of biomaterials, surface properties, physical and Mechanical properties of Bio materials. Metallic Implants Materials: Stainless Steel, Co-based alloys, Ti and Ti based alloys, Important of stress corrosion cracking, Host tissue reaction with Bio metal, corrosion behaviour, hard tissue replacement implant, orthopaedic implant, dental implants, Percutaneous and skin implants, Vascular implants, Heart valve implant.

Module-2

Polymeric Implant Materials: polyolefins, polyamides, acrylic polymers, fluoro carnon polymers, Silicon rubber acetals. Visco elastic behaviour, creep recovery, stress relaxation, strain rate sensitivity, importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives, aging and environmental stress cracking, physiochemical characteristics of bio polymers, bio degradable polymers for medical purpose and their biological applications. Ceramic Implant Materials: Definitions of Bio ceramics, common type of Bio ceramics, Aluminium oxides, Glass ceramics, Carbons. Bioresorbable and Bioactive ceramics, Importance of wear resistance and low fracture toughness. Host Tissue reactions, Importance of Interfacial tissue reaction.

Module-3

Composite Implant Materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement, polymers filled with osteogenic fillers (e.g. hydrosyapatite). Host tissue reactions. Bio Compatibility And Toxicological Screening Of Bio Materials: Definition of bio compatibility, blood compatibility and tissue compatibility, toxicity tests, acute and chronic toxicity (in situ implantation, tissue culture, haemolysis, thrombogenic, potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.

Module-4

Testing Of Bio Materials Implants: In vitro testing (Mechanical testing): tensile, compression, wears, fatigue, corrosion studies and fracture toughness. In vivo testing (animals): biological performance of implants. Exo- vivo testing, standards of implant materials.

Module-5

Sterilisation Techniques: ETO, gamma radiation, autoclaving, Effects of Sterilisation on material properties.

Course outcomes:

At the end of the course the student will be able to:

- Students will be able to know various biomaterials
- Knowledge of its testing methods
- will be able to understand the significance of its use in various industrial applications.
- Apply sterilization techniques in industry.
- Develop models to demonstrate his knowledge.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1., Biological performance of materials, Jonathan Black, MarceDecker,1981.
2., Blood Compatible Materials and Devices, C.P. Sharma & M. Szyehen, Technonic Publishing Co Ltd.,1991.

Reference Books

1, Polymetric Biomaterials. Piskin and S.Hofmann Mantinus Nijhoff publication bordrechnt 1986.
2., Biomaterials, Science and engineering, J.B. Park, Plenum Press 1984
3. Biomaterials, Sujata V. Bhat, Narosa Publishing House – 2002

20MTE15 - GAUGES AND MEASUREMENTS

Group no.	**2**	Subject Code	20MTE15	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**GAUGES AND MEASUREMENTS**				

Module-1

Introduction: Definition and objectives of metrology, Linear measurement: neutral axis significance, imperial standard yard, international standard meter, airy points, Basel points, Line, End & Wave length standards, Slip Gages.

Angular Measurement: introduction, comparisons with linear measurement, sine bar: principle, types, advantages & limitations, uses, problems on sine bar, practical uses, material, construction, limitations problems on angle

blocks (angle gauges.

Module-2

Limits, Fits and Tolerance: Definitions, need of tolerance, types of tolerance, tolerance analysis (addition & subtraction of tolerances) interchangeability & selective assembly, representation of holes & shaft as per I.S. class & grade of tolerance,-difference between allowance & tolerance.

Module-3

Fits: Definition, types of fits, (clearance, interference & transition), tolerance disposition chart, problems (calculation of fits) hole base system & shaft base system, procedure for solving on finding the hole & shaft tolerance upper & lower limits.

Module-4

Design Of Gauges: Taylor's principle, MMC & LMC of hole & shaft types of gauges (plain, threaded, limit, single end , double end, progressive, position, etc.,) important points for gauge design, limitations of gauges, -problems on gauge design.

Module-5

Geometric Dimensioning & Tolerancing (Gd&T) Introduction, ANSI, ASME & ISO systems of Gd&T, functional dimensioning, feature & feature of size, advantages & limitations, feature control frame, fourteen characteristic symbols, form controls, profile controls, orientation controls, location controls, run-out controls,
datum.
Design Exercise: Design of Plug Gauge, Ring Gauge, Snap Gauge, Indicator Gauge, Taper plate Gauge, Taper Plug Gauge, Thread Gauge and Position Gauge.

Course outcomes:
At the end of the course the student will be able to:

1. Students will be able to understand specification of limits, fits and tolerance,
2. Design knowledge of different gauges and their uses,
3. Understanding the Interference of fits and their needs in calculations,
4. To know the different types of Geometric dimensioning and tolerance and
5. Awareness of design knowledge in different gauges in manufacturing.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

1. Engineering Metrology - R.K. Jain
2. Westermann Tables for metal trade – Juts Scharkus, New age international Publishers.
3. Engineering Metrology, K. J. Hume.

Reference Books

1. Geometric Dimensioning and Tolerancing -A Self Study Workbook By Alex Krulikowski.
2. Fundamentals of Geometric Dimensioning and Tolerancing. ASME Y 14.5 M-1994, By Alex Krulikowski.
3. Geometric Dimensioning and Tolerancing for Mechanical Design. McGraw Hill.

Group no.	**2**	Subject Code	20MCM333	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**VIRTUAL INSTRUMENTATION**				

Module-1

Virtual Instrumentation: An introduction

Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, and comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems.

Module-2

VI programming techniques:

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Module-3

Data acquisition basics:

Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

Module-4

VI Interface requirements:

Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

Module-5

VI toolsets:

Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control

Course outcomes:

At the end of the course the student will be able to:

- Explain virtual instrument concepts.
- Select proper data acquisition hardware and Configure data acquisition.
- Familiarize the basics and interfacing of VI
- Discuss operating systems required for virtual instrumentation.
- Create virtual instruments for practical works

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) LabVIEW Graphical Programming, Gary Johnson, Second edition, McGraw Hill, Newyork, 1997.

(2) LabVIEW based Advanced Instrumentation Systems, S. Sumathi and P. Surekha, Spinger.

(3) PC Interfacing for Data Acquisition and Process Control Gupta S.and Gupta J.P Instrument society of America, 1994

Reference Books

(1) PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Kevin James, Newnes, 2000.

(2) WEB RESOURCES: www.ni.com

(3) LabVIEW for everyone, Lisa K. wells & Jeffrey Travis Prentice Hall, New Jersey, 1997.

Group no.	**2**	Subject Code	20CAE252	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**APPLIED MATERIALS ENGINEERING**				

Module-1

Review of basic concepts: Mechanical behavior of Materials, Mechanical properties of materials, stress and strain, Mohr's strain circle, Elasticity, plasticity, Tensile Testing, stress-strain curve for ductile, brittle and polymer materials, Bridgman correction, Other tests of plastic behavior, Strain hardening of metals mechanism

Module-2

Fatigue, Fracture and Creep mechanisms: curves, effect of mean stress, stress concentration, design estimates, cyclic stress strain behavior, Ductility and Fracture, slip system, Griffiths theory, Orowan theory, theoretical fracture strength, Irwin's fracture analysis, fracture mechanics in design, Creep mechanisms, temperature dependence of creep

Module-3

Modern materials and alloys: Super alloys, Refractory metals, Shape memory alloys,Dual phase steels, Micro alloyed steel High strength low alloy steel, Transformation induced plasticity steel(TRIP steel), Maraging steel, Smart materials, Metallic glass, Quasi crystal, Nano-crystalline materials, metal foams, Compacted graphite cast iron and creep resistant aluminum alloys

Module-4

Surface modifications of materials: Mechanical surface treatment and coating, Case hardening and hard facing, Thermal spraying, Vapor deposition and ion implantation, Diffusion coating, electroplating and Electrolysis, Conversion coating, Ceramic coating, Organic coatings, diamond coating, Laser based surface modification Review of Metal Working: Mechanisms of metal working, Flow-stress determination, Temperature in metal working, strain Rate Effects, Friction and Lubrication, Deformation- zone geometry, Hydrostatic Pressure, Workability, Residual stress

Module-5

Forging: Forging equipment, types, forging in plain strain, calculation of forging loads, forging defects, powder metallurgy forging, and Residual stresses in forging. Rolling: Classification, Rolling of bars and shapes, Forces and geometrical relationship, calculation of rolling loads, variables and defects in rolling, rolling mill control, theories. Extrusion and Sheet metal forming: Classification, Analysis of extrusion process, Deformation, lubrication and defects. Forming methods, shearing and blanking, bending, stretch forming, deep drawing, Limit criteria, Defects.

Course outcomes:

At the end of the course the student will be able to:

- Describe the mechanical behavior of metallic systems and its importance
- Knowledge on engineering alloys and nonmetallic materials and their selection.
- Gain knowledge on different types of surface modifications of materials.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) George E. Dieter, Mechanical Metallurgy, Mc Graw Hill, 2013.

Reference Books

1. Norman E. Dowling, Mechanical Behavior of Materials , Prentice Hall, 2012
2. Kenneth G Budenski and Michael K Budenski Engineering Materials' by Prentice-Hall of India Private Limited, 2009.
3. William F. Hosford & Ann Arbor Robert M. Caddell, Metal Forming : Mechanics and Metallurgy, Cambridge University Press, 2011
4. J.E.Dorn, Mechanical behaviour of materials at elevated temperatures, McGraw Hill, 2000.
5. Henry Ericsson Theis, Handbook of Metal forming Processes, CRC Press, 1999

Group no.	**2**	Subject Code	20MSE332	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**AGILE MANUFACTURING**				

Module-1

Introduction -What is agile Manufacturing? - Competitive environment of the future the business case for agile manufacturing conceptual frame work for agile manufacturing. **08 Hrs**

Module-2

Four Core Concepts: Strategy driven approach - integrating organization, people technology interdisciplinary design methodology. **08 Hrs**

Module-3

Agile Manufacturing and Change Management: The change implications. Post failures in advanced manufacturing, changes on the way, traditional management accounting, paradigm, investment appraisal, product costing - performance, measurement and control systems, Traditional organization, control technological and design paradigms traditional problems in workplace- organizational issues - role of technology. **08 Hrs**

Module-4

Agile Manufacturing Enterprise Design: Agile manufacturing - enterprise design, system concepts as the basic manufacturing theory - joint technical & organizational design and a model for the design of agile manufacturing enterprise, enterprise design process insights into design processes, what is interdisciplinary design, Main issues - simple design example. **08 Hrs**

Module-5

Skill & Knowledge Enhancing Technologies for Agile Manufacturing: Skill and Knowledge enhancing Technologies - scheduling - technology design strategic-Design Concepts. Design and Skill of Knowledge enhancing Technologies for machine tool systems - Historical overview, Lessons, problems and Future development.
08 Hrs

Course outcomes:

At the end of the course the student will be able to:

1. Understand the agile manufacturing and conceptual frame work.
2. Analyse the four core concept of agile manufacturing.
3. Study the implication of advanced manufacturing system.
4. Understand and design the agile manufacturing enterprises.
5. Design skill and knowledge enhancing technology for agile manufacturing.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

(1) Agile manufacturing - Forging new Frontiers - Paul T. Kidd - Addison WesleyPublication -1994.

(2) Agile Manufacturing – Proceedings of International Conference - Dr. M.PChowdiah (Editor) – TataMcGraw Hill Publications - 1996.

(3) On agile manufacturing - Tata McGraw Hill Publications -1996

Group no.	**2**	Subject Code	**20MEM15**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MANAGERIAL ECONOMICS**				

Module-1
Demand Analysis: Demand Theory, Preference and Choice, Empirical Demand Curves, Goods Characteristics Approach. **Production & Cost:** Production Theory and Estimation: Organization of Production and the Production Function, Production Function with two variable inputs, optimal combination of inputs returns to scale. Empirical production functions. Cost Components – Cost functions, EmpiricalCostfunctions **10HRs**
Module-2
Market Structures: Perfect Competition: Meaning characteristics and importance, price and output determination in the short run and long run. Derived demand for inputs, shortcomings of perfect competition.
Module-3
Monopoly: Meaning, characteristics and importance, comparison with perfect competition, short run and long run analysis evaluation. Monopolistic Competition: Meaning, Characteristics and Importance short run and long run analysis. **Oligopoly**: Meaning, characteristics and importance, Non-Collusive Oligopoly and the kinked demand curve, Collusive Oligopoly, efficiency implications ofoligopoly. **10HRs**
Module-4

Pricing in Practice: Cost-plus pricing, Evaluation of cost plus pricing, Incremental Analysisin pricing. **10HRs**
Module-5
Capital Budgeting: Meaning and Importance, Protecting Cash Flows, Present Value and Internal Rate of Return, Comparison of NPV and IRR. Economic Growth, Development and planning economic aggregates andeconomicrelationships. **10HRs**
Course outcomes: At the end of the course the student will be able to: 1. Understand concept like flow of economic activity, profit and demand and priceelasticity. 2. Estimate production functions with one and two inputvariables. 3. Find optimistic cost considering all relevantfactors. 4. Compare monopoly and oligopoly competition in market and barriers toenter. 5. Understand pricing on multiple product and employment ofinput.
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20marks. • There will be two full questions (with a maximum of four sub questions) from eachmodule. • Each full question will have sub question covering all the topics under amodule. • The students will have to answer five full questions, selecting one full question from each module.■
Textbooks

(1) **Economics: Principles, Problems and Policies** – Campbell R. McConnell – McGraw Hill – 2005
(2) **Theory and Problems of Micro Economic Theory** – Dominic Salvator, McGraw Hill – 1991
Reference Books
(1) **Managerial Economics** – Joel Dean – PHI – 2005.
(2) **Managerial Economics** – Dominic Salvator, McGraw Hill – 1995.

Group no.	**2**	Subject Code	20MTE321	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCED MOULDING TECHNIQUES**				

Module-1
Injection Moulding Technology : Microprocessor control injection moulding machine, close loop control, open loop control, CNC control, multi color injection moulding, rotary injection moulding, structural foam moulding, sandwich injection moulding**.** **Metal injection moulding:** contact injection moulding, moulding of cellular product like EPS, steam chest moulding, future trends in injection moulding like external & internal inter locking alignment of large moulds, processing of specialty polymers.
Module-2

Extrusion: General consideration during extrusion process like specific heat, latent heat, internal conductivity, shape & size of granular hygroscopic nature over temperature, effect of flow property like relaxation time & defects like shark skin, elastic turbulence, influence of TG, TM & crystal growth rate, cooling rate, impact strength, manufacturing of woven sacks etc. co extrusion, co extruded pipe, muilt layer pipe, foam pipe, biaxial oriented pipe.

Module-3

Lamination : Lamination by extrusion coating, twin screw extrusion, co-rotating & counter rotating, feeding mechanism in twin screw extruder, roll of side feede injection feeder, principles of compounding, mixing mechanism etc**.**

PTFE Moulding: Processing techniques used for PTFE, Material consideration, sintering, Ram extrusion, and Paste extrusion, lso statistic. Moulding and skewing technique for PTFE processing.

Module-4

Blow Moulding: Micro processor / CNC controlled blow moulding machine, injection stretch blow moulding of PET, precut moulding, multi layer blow moulding, Parission programming.

Reaction Injection Moulding (RIM): RIM of Polyurethane, material for RIM, liquid RIM & its advantages over conventional injection moulding, RRIM**.**

Module-5

Advancement in Other Processing Technique: New techniques like Resin transfer moulding, Pultrusion. Filament winding, multi layer rotation moulding, Electro plating and printings, Centrifugal casting, Shrink film, Clink film.

Course outcomes:

At the end of the course the student will be able to:

1. Students will be able to demonstrate their knowledge in the field of advanced moulding methods.
2. Understanding the process and consideration in extrusion process.
3. Learning the techniques in PTEF moulding.
4. Learning the advanced Reaction Injection Moulding
5. Knowledge of advance techniques like, Resin transfer mould, electro plating etc.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Injection Moulding, by Rubin.
2. Extrusion –Berln.
3. Injection Mold by Glavin & Denton

Reference Books

1. Extrusion Die Design, M. V. Joshi.
2. Polymer Chemistry, Gowriker.

Group no.	**2**	Subject Code	20MMD23	Exam Duration	03 Hours

		Exam Marks	100
Subject Title	**TRIBOLOGY AND BEARING DESIGN**		

Module-1

Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's Poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems.

Module-2

Hydrodynamic Lubrication: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynold's equation in two dimensions with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems

Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.

Module-3

Hydrostatic Bearings: Hydrostatic thrust bearings , hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.

EHL Contacts: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.

Module-4

Antifriction bearings: Advantages, selection, nominal life, static and dynamic load earing capacity, probability of survival, equivalent load, cubic mean load, bearing Mountings.

Porous Bearings: Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings,Equations for porous bearings and working principal, Fretting phenomenon and its stages.

Module-5

Magnetic Bearings: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

Course outcomes:

At the end of the course the student will be able to:

01	Design or choose efficient tribological systems such as rolling element bearings, hydrodynamic bearings, and dry sliding bearings, for the needs of a specific application.
C02	Select compatible materials for minimizing friction and wear in machinery.
C03	Explain the concepts advanced bearings like magnetic bearings, porous bearings and gas lubricated bearings.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing, New Delhi 2001
2. Radzimovsky, "Lubrication of Bearings - Theoretical principles and design" Oxford press Company, 2000.

Reference Books

1. Dudley D.Fulier " Theory and practice of Lubrication for Engineers", New York Company.1998
2. Moore "Principles and applications of Tribology", Pergamon press, 1975.
3. Oscar Pinkus, BenoSternlicht, “Theory of hydrodynamic lubrication”, McGraw-Hill, 1961.
4. G W Stachowiak, A W Batchelor ,“Engineering Tribology”, Elsevier publication 1993.
5. Hydrostatic and hybrid bearings, Butterworth 1983.
6. F. M. Stansfield, Hydrostatic bearings for machine tools and similar applications, Machinery Publishing, 1970.

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Group no.	**2**	Subject Code	20MST253	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MECHANICAL Methods in Engineering**				

Module-1

Strength of materials- basic assumptions, elastic and plastic behaviour, stress–strain relationship for elastic behaviour, elements of plastic deformation of metallic materials Mohr’s circle, yielding theories. Theory of plasticity: Elements of theory of plasticity, dislocation theory properties of dislocation, stress fields around dislocations, application of dislocation theory to work hardening, solid solution strengthening, grain boundary strengthening, dispersion hardening.

Module-2

Ductile and Brittle Fracture: Ductile and brittle fracture, Charpy and Izod testing, significance of DBTT, ECT, NDT and FATT; elements of fractography - Griffith’s theory, LEFM– COD and J integral –determination of KIC, COD and J integral. Characteristics of fatigue failure: Initiation and propagation of fatigue cracks, factors affecting fatigue strength and methods of improving fatigue behaviour – testing analysis of fatigue data mechanics of fatigue crack propagation, corrosion fatigue.

Module-3

Introduction to creep: - creep mechanisms, creep curve, variables affecting creep, accelerated creep testing, development of creep resistant alloys, Larsen Miller parameter – Manson Hafred parameter.

Module-4

Stages of failure analysis, classification and identification of various types of fracture.Overview of fracture mechanics, characteristics of ductile and brittle fracture. General concepts, fracture characteristics revealed by microscopy, factors affecting fatigue life Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure. Some case studies failures.

Module-5

Types of wear, analyzing wear failure. Corrosion failures- factors influencing corrosion failures, overview of various types of corrosion stress corrosion cracking, sources, characteristics of stress corrosion cracking. Procedure for analyzing stress corrosion cracking, various types of hydrogen damage failures. Causes of failure in forging; failure of iron and steel castings, improper heat treatment, stress concentration and service conditions. Failure of weldments - reasons for failure procedure for weld failure analysis.

Course outcomes:

At the end of the course the student will be able to:

- Students will develop skill sets to analyse behaviour of materials
- analyse its characteristics to find its adoptability for an industrial application.
- Identify various stages of failure
- Thorough knowledge of wear
- Understand the stages of failure

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Mechanical Behaviour of Materials (MCGRAW HILL SERIES IN MATERIALS SCIENCE AND ENGINEERING) Hardcover – Import, 1 Mar 1990 – Thomas Courtney.
2. Mechanical Behavior of Materials: Second Edition Front Cover Thomas H. Courtney Waveland Press, 16-Dec-2005 - Technology & Engineering.
3. Mechanical Metallurgy', Dieter G. E 3rd Edition, McGraw Hill, 1988.
4. Testing of Metallic Materials', Suryanarayana Prentice Hall India, 1979.
5. Structure and Properties of Materials', Rose R. M., Shepard L. A., Wulff J., Volume III, 4th Edition, John Wiley, 1984

Reference Books

1. ASM Metals Handbook "Failure Analysis and Prevention", ASM Metals Park. Ohio, Vol.10, 10th Edition, 1995.
2. "Analysis of Metallurgical Failures", Colangelo.V.J. and Heiser.F.A., John Wiley and Sons Inc. New York, USA, 1974.

3	**20MPM321**	**Rapid prototyping**
3	**20MEM253**	**Robust Design**
3	**20MTP14**	**Combustion Thermodynamics**
3	20MTP332	Non conventional Energy Resources
3	**20MTP252**	**Modelling and Simulation of thermal system**
3	20MMD241	Creative Engineering
3	**20MMD251**	**Automobile system Design**
3	**20MST244**	**Advances in Material and Processing**
3	20MTE333	Computer control of manufacturing system
3	20MCM321	Logistics and supply chain management
3	20CAE241	C IM and Robotics for automation
3	**20MSE324**	**Precision Engineering**
3	**20MEM22**	**Human Resources Management**
3	20MTE22	Jigs and Fixture Design
3	20MMD12	Design of Vibration control system

20MPM321 - Rapid prototyping

Group no.	**3**	Subject Code	20MPM321	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**RAPID PROTOTYPING**				

Module-1

Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.

Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

08 Hrs

Module-2

Selective Laser Sintering and Fusion Deposition Modeling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications.

Solid Ground Curing: Principle of operation, Machine details, Applications.

08 Hrs

Module-3

Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.

Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer. GenisysXs printer HP system 5, object Quadra systems.

08 Hrs

Module-4

Rapid Tooling: Indirect Rapid tooling -Silicone rubber tooling – Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

08 Hrs

Module-5

RP Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

08 Hrs

Course outcomes:
At the end of the course the student will be able to:
1. Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications.
2. Explain direct metal laser sintering, LOM and fusion deposition modeling processes.
3. Demonstrate solid ground curing principle and process.
4. Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components.
5. Understand the RP Process Optimizations.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) 1. Stereo lithography and other RP & M Technologies - Paul F. Jacobs - SME, NY 1996.

(2) 2. Rapid Manufacturing - Flham D.T &Dinjoy S.S - Verlog London

Reference Books

(1. Wohler's Report 2000 - Terry Wohlers - Wohler's Association - 2000.

Group no.	**3**	Subject Code	**20MEM253**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ROBUST DESIGN**				

Module-1

Quality by Experimental Design : Quality, western and Taguchi quality philosophy, Elements of cost, Noise factors causes of variation, Quadratic loss function and variation of quadratic loss functions.

Robust Design : Steps in robust design : parameter design and tolerance design, reliability improvement through experiments, illustration through numericalexamples.

10Hrs

Module-2

Experimental Design: Classical experiments: factorial experiments, terminology, factors. Levels, Interactions, Treatment combination, randomization, 2-level experimental design for two factors and three factors. 3-level experiment deigns for two factors and three factors, factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples.

10Hrs

Module-3

Measures of Variability : Measures of variability, Concept of confidence level, Statistical distributions : normal, log normal and Weibull distributions. Hipothesis testing, Probability plots, choice of sample size illustration through numerical examples.

Analysis and interpretation of experimental data: Measures of variability, Ranking method, column effect method and ploting method, Analysis of variance (ANOVA), in factorial experiments : YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data, illustration through numerical examples.

10Hrs

Module-4

Taguchi's Orthogonal Arrays : Types orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs, Column merging method, Branching design, Strategies for constructing orthogonal arrays.

Signal to Noise ratio (S-N Ratios) : Evaluation of sensitivity to noise, Signal to noise ratios for static problems, Smaller – the – better types, Nominal – the – better – type, larger – the- better – type. Signal to noise ratios for dynamic problems, Illustrations through numerical examples.

10Hrs

Module-5

Parameter Design and Tolerance Design : Parameter and tolerance design concepts, Taguchi's inner and outer arrays, Parameter design strategy, Tolerance deign strategy, Illustrations through numerical examples.

Reliability Improvement Through Robust Design : Role of S-N ratios in reliability improvement ; Case study; Illustrating the reliability improvement of routing process of a printed wiring boards using robust designconcepts**.**

10Hrs

Course outcomes:

At the end of the course the student will be able to:

1.Create designs that have a minimal sensitivity to input variation 2.Reduce design costs
3. Determine which design parameters have the largest impact on variation
4. Optimize designs with multipleoutputs.
5. Understand the Parameter Design and ToleranceDesign.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1)Quality Engineering using Robust Design - Madhav S. Phadake: Prentice Hall, Englewood Clifts, New Jersey 07632, 1989.

(2)Design and analysis of experiments - Douglas Montgomery: Willey India Pvt. Ltd., V Ed., 2007

(3)Techniques for Quality Engineering - Phillip J. Ross: Taguchi 2nd edition. McGraw Hill Int. Ed., 1996

Reference Books

(1)Quality by Experimental Design - Thomas B. Barker - Marcel Dekker Inc ASQC Quality Press, 1985

(2)Experiments planning, analysis and parameter design optimization -
C.F. Jeff Wu, Michael Hamada - John Willey Ed., 2002

(3)Reliability improvement by Experiments - W.L. Condra, - Marcel Dekker Inc ASQC Quality Press, 1985

Group no.	3	Subject Code	20MTP14	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**COMBUSTION THERMODYNAMICS**				

Module-1

Introduction: Thermodynamics-equation of state, properties of gas mixtures, First law analysis of reacting systems, enthalpy of formation and heat of reaction, stoichiometric and equivalence ratio, adiabatic flame temperature. **Fuels and combustion**: Coal, fuel oil, natural and petroleum gas, emulsion firing, coal – oil and coal – water mixtures, synthetic fuels, bio-mass, combustion reactions, heat of combustion and enthalpy of combustion, theoretical flame temperature, free energy of formation, equilibrium constant, effect of dissociation. Combustion Mechanisms: Kinetics of combustion, mechanisms of solid fuel combustion, kinetic and diffusion control, pulverized coal firing system, fuel-bed combustion, fluidized bed combustion, coal gasifiers, combustion of fuel oil, combustion of gas, combined gas fuel oil burners, Requirements for efficient combustion , Recent trends in furnace /combustion chamber.

Module-2

Second law of thermodynamics and concept of chemical equilibrium: Gibbs free energy and the equilibrium constant of a chemical reaction (Vant-Hofts equation). Calculation of equilibrium Composition of a chemical reaction.

Module-3

Chemistry of Combustion: Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics. **Physics of Combustion:** Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.

Module-4

Premixed Flame: One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame

Module-5

Diffusion Flame: Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion, Combustion and Environment: Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods.

Course outcomes:

At the end of the course the student will be able to:

CO1: Understand the basic thermodynamic concepts for combustion phenomena.
CO2: Describe the fuel energy conversion systems.
CO3: Apply the concept of flam flow mechanism in combustion process.
CO4: knowledge of adiabatic flame temperature in the design of combustion devices.
CO5: Identify the phenomenon of flame stabilization in laminar and turbulent flames.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Mishra, D.P., Introduction to Combustion, Prentice Hall,2009

(2)Sharma, S. P., Fuels and Combustion, Tata McGraw Hill, New Delhi, 2001.

(3) Heywood Internal Combustion Engine Fundamentals, McGraw Hill Co.1988

Reference Books

(1) Thermodynamics – An Engineering Approach, Yunus Cengel and Michael Boles,7th Ed., Tata McGraw Hill

(2) Modern Engineering Thermodynamics, Robert Balmer, Elseveir.

(3)Advanced Thermodynamics for Engineers, Kenneth Wark, McGraw Hill

(4)Principles of Combustion, Kuo K. K., John Wiley and Sons.

(5)An Introduction to Combustion concepts and application by Stephen R. Turns, McGraw Hill Heigher Education, 2000.

Group no.	3	Subject Code	20MTP332	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**NON-CONVENTIONAL ENERGY SOURCES**				

Module-1

Introduction: Energy source, India's production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, solar, thermal, photovoltaic. Water power, wind biomass, ocean temperature difference, tidal and waves, geothermal, nuclear (Brief descriptions). **Solar Radiation:** Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. **Measurement of Solar Radiation:** Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working.

Module-2

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sum, day length, numerical examples. **Solar Thermal systems:** Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems. Solar pond, principle of working. **Solar Photovoltaic systems:** Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction

Module-3

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, elementary design principles; coefficient of performance of a wind mill rotor, aerodynamic considerations of wind mill design, numerical examples.

Module-4

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations. **Ocean Thermal Energy Conversion:** Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC.

Module-5

Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy. **Energy from Bio Mass**: Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of biogas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages

Course outcomes:

At the end of the course the student will be able to:

- Describe the need of renewable energy resources, historical and latest developments.
- Describe the use of solar energy and the various components used in the energy production with respect to applications like-heating, cooling, desalination, power generation, drying, cooking etc.
- Appreciate the need of Wind Energy, wave power, tidal power, ocean thermal power and geothermal and the various components used in energy generation.
- Understand the concept of Biomass energy resources and their classification, types of biogas Plants applications

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Non-Conventional Energy Sources, G.D Rai, Khanna Publishers, 2003.
2. Non-Convention Energy Resources, B H Khan, McGraw Hill Education (India) Pvt. Ltd. 3rd Edition

3. Solar energy, Subhas P Sukhatme, Tata McGraw Hill, 2nd Edition, 1996.
4. Renewable Energy Sources and Conversion Technology, N K Bansal, Manfred Kleeman & Mechael Meliss, Tata McGraw Hill. 2004.
5. Non-Conventional Energy, Ashok V Desai, Wiley Eastern Ltd, New Delhi, 2003.
6. Renewable Energy Technologies, Ramesh R & Kumar K U, Narosa Publishing House, New Delhi.

Group no.	**3**	Subject Code	20MTP252	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MODELING AND SIMULATION OF THERMAL SYSTEMS**				

Module-1

Principle Of Computer Modeling And Simulation: Monte Carlo simulation, Nature of computer modeling and simulation, limitations of simulation, areas of application. **System and Environment:** components of a system-discrete and continuous systems. Models of a system-a variety of modeling approaches.

Module-2

Random Number Generation: technique for generating random numbers —mid squad e method- The mid product method-constant multiplier technique-additive congruential method- linear congruential method —tests for random number s —the kolmogorov-simrnov test-the Chi-square test. **Random Variable Generation:** inversion transforms technique- exponential distribution- uniform distribution-weibul distribution empirical continuous distribution- generating approximate normal variants-Erlang distribution.

Module-3

Empirical Discrete Distribution: Discrete uniform distribution—poisson distribution geometric distribution- acceptance-rejection technique for poission distribution-gamma distribution. **Design And Evaluation Of Simulation Experiments**: variance reduction techniques-antithetic variables- variables-verification and validation of simulation models.

Module-4

Discrete Event Simulation: concepts in discrete-event simulation, manual simulation using event scheduling, single channel queue, two server queue simulation of inventory problem.

Module-5

Introduction to GPSS: Programming for discrete event systems in GPSS, case studies.

Course outcomes:

At the end of the course the student will be able to:

- CO1: Explain the basic principles and concepts underlying in modeling and simulation Techniques.
- CO2: Optimize the design of thermal systems.
- CO3: Develop representational modes of real processes and systems.
- CO4: Generate suitable modelling techniques to compute the performance.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Discrete event system simulation - Jerry Banks & John S Carson II, prentice hall Inc, 1984.
2. Systems simulation - Gordon g, prentice Hall of India Ltd, 1991.
3. System simulation with digital Computer - NarsinghDeo, Prentice Hall of India, 1979.
4. Thermal Power Plant Simulation & Control - D. Flynn (Ed), IET, 2003.

Group no.	3	Subject Code	20MMD241	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**CREATIVE ENGINEERING**				

Module-1

Introduction Creative thinking, blocks to creativity, factors that influence creative design, engineering design and creative design, influence of society, technology and business on creativity, force field analysis, market pull & technology push, attribute of a creative person, creative thinking in groups, creating a creative climate. CREATIVITY & PRODUCT DESIGN Need or identification of a problem, market survey, data collection, review & analysis, problem definition, Kipling method, challenge statement, problem statement initial specifications

Module-2

Idea Generation Brain storming, analogy technique or synectics, check list, trigger words, morphological method, interaction matrix method, analysis of interconnected decision making, CREATIVE THINKING PROBLEM / OPPORTUNITY Pictures of situation, environment, quantification, Heros, boundary conditions, record discuss-clarify-verify, recording of ideas, evaluation of ideas, detail design, prototyping, product deployment, useful life assessment, recycling.

Module-3

Emotional Design Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective- design by individual and design in groups, designs with personality – machines that senses emotions and induce emotions- Robots, personality products, products for games, fun, people and places; Simulation – dimensional or mathematical, virtual simulation, physical simulation, scale down models.

Module-4

Theory Of Inventive Problem Solving (Triz) Common features of good solutions – resolve contradiction, use available resource, increase the ideality, trade-off, inherent contradiction, 30 key TRIZ principles – multifunction, preliminary action, compensation, nested doll, blessing in disguise, segmentation, separation, regional influences, symmetry change, opaque & porous, inflate and deflate, color, recycle & recover, phase transformation, energy, imaging, environment, composition, economical, surface response, equipotential, static & dynamic, continuous & intermittent, servo systems, smart systems, dimensions

Module-5

Application Of Ceda Approach: (a) Cooking stove for rural India; (b) utilizing solar energy; (c) water filtration systems; (d) automation in healthcare; (e) technologies for law enforcement; (f) application of robots to reduce human fatigue (g) Layout of berths in a railway coach.

Course outcomes:

At the end of the course the student will be able to:

CO1. Explain the steps involved in the creative thinking process

CO2. Apply the various techniques for stimulating creativity and innovation thinking

CO3. Analyze the techniques to design and develop new products.

CO4. Synthesize the creative design with analysis to develop new products

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. Amaresh Chakrabarti, Creative Engineering Design Synthesis, Springer, 2009
2. Floyd Hurt, Rousing Creativity: Think New Now, Crisp Publ Inc. 1999, ISBN 1560525479
3. Donald A. Norman,Emotional Design, Perseus Books Group New York , 2004, ISBN 123-1-118- 027-6
4. Kalevi Rantanen & Ellen Domb, Simplified TRIZ – II edn., Auerbach Publications, Taylor & Francis Group, 2010, ISBN: 978-142-0062-748

Group no.	3	Subject Code	20MMD251	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**AUTOMOBILE SYSTEM DESIGN**				

Module-1

Body Shapes: Aerodynamic Shapes, drag forces for small family cars.
Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI), energy audit

Module-2

Design of I.C. Engine I: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines.

Module-3

Design of I.C. Engine II: Design of crankshaft, camshaft, connecting rod, piston &piston rings for small family cars (max up to 3 cylinders)

Module-4

Transmission System: Design of transmission systems – gearbox (max of 4- speeds), differential suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension.

Module-5

Cooling System: Heat exchangers, application to design of cooling system (water cooled).
Emission Control: Common emission control systems, measurement of emissions, exhaust gas emission testing

Course outcomes:

At the end of the course the student will be able to:

CO1. Gain an insight into aspects of vehicle design, operation and maintenance, which will be useful for taking up a position in the automotive industry.
CO2. Apply the knowledge in creating a preliminary design of automobile subsystems.
CO3. Identify construction, working, preventive maintenance, trouble shooting and diagnosis of various Automobile Systems.
CO4. Identify Modern technology and safety measures used in Automotive Vehicles.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Design of Automotive Engines, -A.Kolchin&V. Demidov, MIR Publishers, Moscow.
2. The motor vehicle, Newtonsteeds &Garratte-Iliffee&sonsLtd.,London.
3. I.C. Engines -Edward FObert,International text book company.

Reference Books

1. Introduction to combustion-Turns.
2. Automobile Mechanic-, N.K.Giri, Khanna Publications, 1994
3. I.C. Engines -Maleev, McGraw Hill book company, 1976
4. Diesel engine design- HeldtP.M.,Chilton companyNew York.
5. Problems on design of machine elements- V.M. Faires &Wingreen, McMillan Company.,1965
6. Design of I.C.Engines -John Heywood, TMH.

Group no.	3	Subject Code	20 MST 244	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCES IN MATERIALS AND PROCESSING**				

Module-1

Classification and Characteristics: Metals, Nonferrous Metals and Ferrous Metals, classification of Ferrous Metals and Non-Ferrous Metals, Types of Ceramics, Polymers and composites and classification of composites. General Properties and Structure: Atoms, molecules bonds in solids, Crystalline – Defects in Metallic structure, Dislocations and plastic deformation - Strengthening mechanism – grain size, dislocation - Cold work, precipitation hardening, dispersion hardening - phase reactions, fatigue and Creep behaviour.

Module-2

Ferrous Alloys: iron carbon equilibrium diagrams - Steels and cast irons - properties, structure, composition and applications transformation hardening in steels - TIT diagrams - Heat treatment processes - Effect of alloying elements - High alloy steels, Stainless steel types, tool Steels, Manganese steels, heat resistant steels, HSLA, Managing steels. Non-Ferrous Alloys: Alloys of copper, Aluminium, nickel, magnesium, titanium, lead, tin, Zinc - composition, heat treatment, structure, properties and application.

Module-3

Polymers and Polymerizations: Structure and properties of thermoplastics and thermosets – Engineering Applications - property modifications - Mechanical and thermal behaviour – processing methods Ceramics: Nature and structure of Ceramics - Refractory Abrasives glasses - glass ceramics - Advanced ceramics processing methods.

Module-4

Composites: Definition - classification and characteristics of composite materials - Volume fraction - laminated composites particulate composites, fibrous composites – Types of reinforcements, their shape and size - production and properties of fiber reinforced plastics, Metal Matrix composites and ceramic matrix composites - Applications.

Module-5

Processing of Polymers: composites, ceramics - thermal spraying - Ion beam machining diamond coating techniques-tribological applications.

Course outcomes:

At the end of the course the student will be able to:

1. Understand and apply the various processing and manufacturing techniques. (PO-5)
2. Knowledge of basics of process and important parameters of equipment design. (PO-3)
3. Understand and apply the techniques and their characteristics/limitations of synthesis of polymers. (PO-1,5)
4. Understand the structure-processing-property relationship of metals and polymers. (PO-3)
5. Understand the basic issues involved in polymer blends, metal matrix composites and ceramic matrix composites. (PO-2)
6. Understand the significance of alloying element and phase diagrams. (PO-3,4)

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

Advanced Materials and Processes - James W. Evans Lutgard C. De Jonghe. Springer Publications – 2016.
1. Engineering Metallurgy - Raymond and Higgens - ELBS/EA
2. Introduction to Material Science and Engineering James. F. Shackleford - Mc Millan, NY - 7th edition.

Reference Books

1. Powder Metallurgy-Metals Hand Book -ASM, USA - Vol.7, 1974.
2. Composite Materials - Science and Engineering - Chawla K.K. , - Springer - Verlag, New york - 2nd edition, 1998.
3. Cast Metal Matrix Composites ASM Metals Hand Book - P.K. Rohagti - VI5.
4. Elements of Material Science and Engineering - Van Vlack L.H. - Addison Wesley, NY- 1989.
5. Material science and metallurgy - by Callister, John Willey & Sons.

Group no.	3	Subject Code	20MTE333	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**COMPUTER CONTROL OF MANUFACTURING SYSTEMS**				

Module-1

Introduction to Computer integrated Manufacturing Systems: Manufacturing Systems, Types of Manufacturing Systems, Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, The Product Cycle and CAD/ CAM, Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems,

NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit, CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors, Feed back Devices: Encoder, Resolver, Inductosyn, Tachometers, Counting devices, Digital to analog converters.

Module-2

Interpolations: DDA integrators, simple and symmetrical DD reference word CNC interpolators. **Control loops for N C Systems:** Introduction-control loops for point and counting systems.

Constructional Features of CNC Machines: Design considerations of CNC machines for improving machining accuracy, Structural Members, Slide ways, bearings, Re-circulating ball Screws, Spindle drives, Work holding devices and tool holding devices, Automatic tool changers: Principles of Operation, Machining Centers, Tooling for CNC machines.

Module-3

N.C part programming: Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming.

Computer Controls in NC: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control(DNC Systems): Configuration of DNC system, , Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC, Adaptive control machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining

Module-4

Industrial Robotics : Robotics technology : Types of Robots, Robot Technology Levels, Robot geometric configurations and Technical Features, basic robot motions, Robot control systems, robot drive systems, Work-cell control and Interlocks, robot sensors, robot safety, robot-computer interface, industrial robot applications and benefits, robot programming and programming languages

Module-5

Computerized Manufacturing Planning and Control Systems: Computer aided process planning, Variant and Generative approaches, Computer integrated production planning and control systems, Typical production planning and control system, Material planning systems, Capacity planning, Shop Floor Control, Automatic identification, Automated data collection systems.

Course outcomes:

At the end of the course the student will be able to:

1. Students will get clear understanding of NC/CNC machines, Various elements of CNC machines and its uses.
2. Understanding the Constructional features of CNC machine Tools
3. Knowledge of CNC programming and its implementation.
4. Knowledge of Robotic technology.
5. Awareness of Computerized manufacturing planning and Control systems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Automation, Production Systems and Computer Integrated Manufacturing, GROOVER M P, Prentice Hall India (P) Ltd, 1989.
2. CAD/CAM Computer Aided Designand Manufacturing, Mikell P. Groover and Emory W. Zimmer Jr, Prentice Hall India (P) Ltd, 1992. (unit 1).
3. Computer Controls of Manufacturing Systems, M. Koren, Mc GrawHill, 1983.

Reference Books

1. Numerical control of machine tools". Martin J.
2. CAD/CAM Principles and Applications P.N. Rao, Mc Grawhill 200.2
3. Numerical control of machine tools - Y. Koren & J. Benuri, Khanna, 1992.
4. Numerical control in manufacturing- Wilson, F.M Mc Graw Hill Newyork.
5. Theory and Design of CNC Systems, Suk-Hwan Suh, Seong-Kyoon Kang, Dea-Hyuk Chung and Ian Stroud, Springer, 2008.

Group no.	**3**	Subject Code	20MCM321	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**LOGISTICS AND SUPPLY CHAIN MANAGEMENT**				

Module-1

Introduction: Definition of logistics and supply chain management, decision phases in a supply chain, objectives of SCM, examples of supply chains, supply chain drivers, supply chain integration, supply chain performance measures.
Logistics Network Design: Role of distribution in supply chain, distribution network design, factors influencing distribution network design, distribution networks in practice, network design in the supply chain, factors influencing the network design, framework for network design, models for facility location and capacity allocation, Impact of uncertainty on network design.

Module-2

Coordinated Product And Supply Chain Design: General framework - design for logistics - standardization - push-pull boundary - supplier integration into new product development - keys to effective supplier integration - mass customization - meaning - mass customization and supply chain management.

Module-3

Strategic Alliances: Framework for strategic alliances - Third Party Logistics - 3PL issues and requirements - retailer - supplier partnerships - issues in retailer - supplier partnerships - distributor integration - types and issues of distributor integration.

Module-4

Inventory Management: Cycle inventory, economies of scale to exploit fixed costs, quantity discounts, example problems, multi-echelon inventory, safety inventory in supply chain, safety level estimation, supply uncertainty, data aggregation, replenishment policies, managing safety inventory in practice, product availability, optimal level, affecting factors, supply chain contracts - Bull whip effect.

Module-5

Technologies For SCM: Information Technology (IT) - Infrastructure - Interface devices - System architecture - Electronic commerce - IT for supply chain excellence - Service oriented architecture - Radio Frequency Identification (RFID) - Impact of internet.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a clear understanding of the key concepts applied in logistics and supply chain management.
- To highlight the importance of all activities of the supply chain and an understanding of concepts like inbound and outbound logistics, offshore and inshore logistics.
- To develop skills for planning, designing the operational facilities of supply chain with the analytical and critical understanding
- Apply various tools and technics to plan and maintain the inventory
- Demonstrate application information technology in SCM.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1)	Simchi - Levi Davi, Kaminsky Philip and Simchi-Levi Edith, "Designing and Managing the Supply Chain", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2012.
(2)	Sunil Chopra and Peter Meindl, "Supply Chain Management", Prentice Hall, New Jersey, 2010.
(3)	Sadler I, "Logistics and Supply Chain Integration", Sage Publishers, 2007.
(4)	David J. Bloomberg , Stephen Lemay and Joe B. Hanna, "Logistics" PHI
Reference Books	
(1)	Jeremy F. Shapiro, "Modeling the Supply Chain", Thomson Duxbury
(2)	Srinivasan G.S, "Quantitative models in Operations and Supply Chain Management", PHI,
(3)	James B. Ayers, "Handbook of Supply Chain Management", St.Lucle press

Group no.	**3**	Subject Code	20CAE241	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**CIM & ROBOTICS for AUTOMATION**				

Module-1

Introduction to Computer integrated Manufacturing Systems: Manufacturing Systems, Types of Manufacturing Systems, , Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, The Product Cycle and CAD/ CAM, Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems, NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit , CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors, Feedback Devices: Encoder, Resolver, Inductors, Tachometers, Counting devices, Digital to analog converters.

Module-2

part programming: Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming. Computer Controls in NC: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control (DNC Systems): Configuration of DNC system, Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC, Adaptive control machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining.

Module-3

Introduction to Robotics: Automation and Robotics, Historical Development, Definitions, Basic Structure of Robots, Robot Anatomy, Complete Classification of Robots, Fundamentals about Robot Technology, Factors related to use Robot Performance, Basic Robot Configurations and their Relative Merits and Demerits, Types of Drive Systems and their Relative Merits, the Wrist & Gripper Subassemblies. Concepts and Model about Basic Control System, Transformation and Block Diagram of Spring Mass System, Control Loops of Robotic Systems, PTP and CP Trajectory Planning, Different Types of Controllers, Control Approaches of Robots.

Module-4

Kinematics of Robot Manipulator: Introduction, General Description of Robot Manipulator, Mathematical Preliminaries on Vectors & Matrices, Homogenous Representation of Objects, Robotic Manipulator Joint Co-Ordinate System, Euler Angle & Euler Transformations, Roll-Pitch-Yaw(RPY) Transformation, Relative Transformation, Direct & Inverse Kinematics' Solution, D H Representation Displacement Matrices for Standard Configurations, Geometrical Approach to Inverse Kinematics. Homogeneous Robotic Differential Transformation: Introduction, Jacobian Transformation in Robotic Manipulation.

Module-5

Robotic Workspace, Motion Trajectory & Industrial Applications: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. Robotic Motion Trajectory Design: Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories:-4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.

Industrial Applications: Automation in Manufacturing, Robot Application in Industry, Task Programming, Goals of AI Research, AI Techniques, Robot Intelligence and Task Planning, Modern Robots, Future Application and Challenges and Case Studies.

Course outcomes:

At the end of the course the student will be able :

1. To impart the basic concepts in manufacturing systems and fundamentals of NC & CNC system
2. Enhance knowledge in design consideration and increasing productivity with NC machine tools, machining centers and tooling for CNC machines
3. To Understand the robotic system, available tools and technique for kinematics and its applications to industry

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/

1. GROOVER M P, Automation, Production Systems and Computer Integrated Manufacturing - , Prentice Hall India (P) Ltd, 1989.
2. Mikell P. Groover and Emory W. Zimmer, Jr., CAD/CAM Computer Aided Design and Manufacturing, Prentice Hall India (P) Ltd, 1992.
3. M.Koren ―Computer Controls of Manufacturing Systems, McGrawHill, 1983
4. "A Robot Engineering Textbook "– Mohsen Shahinpo or – Harper & Row publishers,
5. "Robotics, control vision and intelligence," Fu, Le e and Gonzalez. McGraw Hill International,1987.
6. "Introduction to Robotics:Mechanics and Control" , J ohn J. Craig, Pearson, 3e, 2009.

Reference Books

1. Martin J. ―Numerical control of machine tools".
2. P.N. Rao – CAD/CAM Principles and ApplicationsMcGra whill 2002
3. Y. Koren&J.Benuri -"Numerical control of machine tools-Khanna, 1992
4. Wilson F.M ―Numerical control in manufacturing- McGraw Hill Newyork
5. Suk-Hwan Suh, Seong-Kyoon Kang, Dea-Hyuk Chung and Ian Stroud, Theory and Design of CNC Systems, , Springer, 2008.
6. 13."Robotics for Engineers", YoramKoren, McGraw Hill International, 1985.
7. 14."Industrial Robotics",Groover, Weiss, Nagel, McGrawHill International, 1986.
8. 15."Robot Technology Fundaments"- Keramas, Thomson Vikas Publication House, 1999.

Group no.	**3**	Subject Code	20MSE324	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**PRECISION ENGINEERING**				

Module-1
CONCEPTS OF ACCURACY AND MACHINE TOOLS: Part Accuracy – errors, accuracy of machine tools – spindle accuracy – displacement accuracy – errors due to numerical interpolation – definition of accuracy of N.C system – errors in the NC machines – feed stiffness – zero stability. **08 Hrs**
Module-2
STIFFNESS, THERMAL EFFECTS AND FINISH MACHINING: Overall stiffness of Lathe – compliance of work piece – errors caused by cutting forces – deformation in turning – boring – milling – heat sources – thermal effects – Finish Turning, boring, grinding – Surface roughness. **08 Hrs**
Module-3
DIMENSIONING: Definition of terms – Key dimension – Superfluous dimension – dimensional stepped shaft – assigning tolerances in the constituent dimensions – dimensional chains. **08 Hrs**
Module-4

MICRO-MACHINING MICRO-FABRICATION: Micro Machining – Photo resist process – Lithography – LIGA Process – Optical, processing of materials – electron beam machining – beam machining – micro forming, diamond turning – micro positioning devices – etching – physical vapour deposition – Chemical vapour deposition. **08 Hrs**

Module-5

SMART STRUCTURES, MATERIALS AND MICRO ACTUATORS: Smart structures – Smart materials types and applications – smart sensors – micro valves –MEMS – Micro motors – Micro pumps – micro dynamometer – micro machines – microoptics – micro nozzles. **08 Hrs**

Course outcomes:
At the end of the course the student will be able to:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) Murthy R.L., "Precision Engineering in Manufacturing", New Age International Pvt, 2005.

(2)JuliarW.Gardner. Vijay K. Varadan, "Micro sensors, MEMS and Smart Devices", John Wiley and sons, 2001.

Reference Books

(1) Stephen A.Campbell,"The Science and Engineering of Microelectronic Fabrication", Oxford University Press, 1996.

(2)Raady Frank, "Understanding Smart Sensors", Artech. House, Boston, 1996.

(3) MEMS Hand Book, CRC Press, 2001.

Group no.	3	Subject Code	20MEM22	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	HUMAN RESOURCES MANAGEMENT				

Module-1

HRM in perspective, competitive challenges, uses of HR information, Demographics and employee concerns, social issues, diversity in. HRM,

Relationship of Job Requirements and HRM functions, Job Analysis, Job Description, Job Design, Designing work for groups, flexible work schedules, Industrial engineering and ergonomic consideration, HR Planning, Effective HRP, Forecasting and balancing supply and demand of HR, recruiting from inside and outside, Recruiting protected class, Recruitingolderpeople. **10Hrs**

Module-2

Selection, Matching people and job, sources of information about job candidate, The US Employee Polygraph Protection Act, graphology, Medical examination, Drug test, Interview methods Guidelines for interviewers, appropriate and inappropriate interview questions, selection decision. **10 Hrs**

Module-3

Developing effectiveness in HR, Investment in Training, System approach, Conducting the .needs assessment, designing training programs, trainee readiness and motivation, principles of learning, characteristics of trainees, training methods for non-managerial employees, OJT, Technology for training, training methods for MDP, Evaluating, benchmarkingHRtraining. **10 Hrs**

Module-4

Career development and Appraisal, identifying career opportunity and requirements, gauging employee potential, career development initiative, Mentor check list, career development for women and minorities, dual career couples, personal career development, Behavioural methods of appraisal, balanced score card, personal score card appraisal interviews;performancediagnosis. **10Hrs**

Module-5

International HRM, Managing across borders, International staffing, Skills of a global manager, content of training program. Non-verbal communications, developing local resources, compensation of host country employees, managers and expatriate managers. Case studies on appraisal system, developing a training session, evaluating a given training program. Preparation of structured and unstructured interviews. **10Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the basic concepts of HRM, Functions and role of HRM.
2. Know methodology of job selection process implemented in various sectors.
3. Analyse the effectiveness in training, evaluating and benchmarking HRtraining.
4. Understand the career development concept and methods of personal appraisal.
5. Understand International activities of HRM, Staffing, communication, appraisal training and interviewsystem.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from eachmodule.■

Textbooks

(1)Managing Human Resources - Wayne F Cascio - Tata McGraw Hill, New Delhi

(2)Managing Human Resources - George Bohlander and Scot Snell - Thompson South western.

Reference Books

(1)Human Resource Management - BiswajeetPattanayak - Prentice Hall of India Pvt. Ltd.

(2)Human Resource Management - K. Ashwathappa,

(3)Personnel Management - C.B.Memoria - Himalaya Publishing.

Group no.	3	Subject Code	20MTE22	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**JIGS AND FIXTURES DESIGN**				

Module-1

Introduction: Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design. Location Degree of freedom, 3-2-1 principles, Choice of location, redundant location, Diamond pin calculation, Locating methods and chip control.

Module-2

Locating Devices: Surface location, Rest blocks, pins, V-blocks, Equalizers, Profile locators, Vee locaters, Nesting locaters, Diamond Pins, adjustable Locaters.
Clamping Devices: Basic principles, cutting forces, Rigid clamping, wedge clamping, cam clamping, quick action clamps, strap clamps, screw clamps, swing clamps, Toggle clamps, simultaneously acting clamps.

Module-3

Guiding Elements, Drill Bushings: Standard Drill Bushing types**,** Jig bushes Installation, Standards, Tool Setting gauges.
Indexing Jigs and Fixtures: Indexing methods, Linear, Rotary, Indexing jigs, Indexing fixtures. Assembly and Welding Fixture – Principles.

Module-4

Design of Jigs and Fixture Bodies, other Elements, types of Jigs and Fixtures: Plate Jigs. Box Jigs, Indexing Jigs, Milling Fixtures and Indexing milling Fixtures, Turning Fixtures, Grinding Fixtures, Universal Jigs & Fixtures, Welding fixtures, Broaching fixtures and assembly fixtures, Modular Fixturing.

Module-5

Preparation and Presentation of typical designs in the form of drawings for the following

1. Drill Jig
2. Drilling and Reaming Jigs
3. Milling Fixtures
4. Indexing Jigs
5. Indexing Milling Fixtures.
6. Turning Fixtures.

Course outcomes:

1. Students understand their knowledge in various jigs and fixtures,
2. Understand the designs of clamping methods,
3. Knowledge of indexing and methods,
4. Knowledge of different applications of fixtures and
5. Drawing exercises of different typical jigs and fixtures.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ▰

Textbook/ Textbooks

1. Jigs & Fixtures - JOSHI P .H.- New Delhi -Tata McGraw Hill Pub. Co. Ltd., 11th print 1999.
2. Jigs. & Fixtures & Gauges -BOYES E. WILLIAM-Michigan -SME 1st Ed. 1986.
3. Jigs and Fixture Design Manual- by Erik k Henriksen, Industrial Press Inc.

Reference Books

1. An Introduction to Jig and Tool Design -KEMPSTER M.H.A.- Bristol- ELBS 3rd Ed. 1974.
2. Jigs and Fixture Hand book by A.K. Goroshkin, MIR pub.
3. Jigs and Fixture Hand book by Carr Lane Mfg Com.

Group no.	3	Subject Code	20MMD12	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN OF VIBRATION CONTROL SYSTEMS**				

Module-1

Review of Mechanical Vibrations Basic concepts: free vibration of single degree of freedom Systems with and without damping, forced vibration of single DOF-systems, Natural frequency.
Vibration Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers, and Vibration dampers

Module-2

Transient Vibration of single Degree of freedom systems: Impulse excitation, arbitrary excitation, Laplace transform formulation, Pulse excitation and rise-time, Shock response spectrum, Shock isolation.
Random Vibrations: Random phenomena, Time averaging and expected value, Frequency Response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.

Module-3

Vibration Measurement and applications: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis.
Modal analysis &Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis

Module-4

Vibration and Noise Control : Basics Of Noise, Introduction, amplitude, frequency, wavelength and sound pressure lavel, addition, subtraction and averaging decibel; levels, noise dose lavel, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis tracking analysis sound quality analysis. Introduction to Automotive noise sources, Engine over-all noise lavels.

Module-5

Continuous Systems: Vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.

Course outcomes:

At the end of the course the student will be able to:
CO1. Apply Newton's equation of motion and energy methods to model basic vibrating mechanical system, model undamped and damped mechanical systems and structures for free and harmonically forced vibrations.
CO2. Model single-and multi-degree of freedom for free and forced vibrations and determine response to vibration, natural frequencies and modes of vibration.
CO3. Apply the fundamentals of vibration to its measurement and analysis.
CO4. Solve realistic vibration problems in mechanical engineering design that involves application of most of the course syllabus.
CO5. Ability to design and develop vibrations and noise control systems

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. S. S. Rao, "Mechanical Vibrations" , Pearson Education, 4th edition.
2. S. Graham Kelly," Fundamentals of Mechanical Vibration" -McGraw-Hill, 2000
3. Theory of Vibration with Application, -William T. Thomson, Marie Dillon

Reference Books

1. S. Graham Kelly," Mechanical Vibrations" , Schaum' s Outlines, Tata McGraw Hill, 2007.
2. C Sujatha," Vibrations and Acoustics – Measurements and signal analysis" , Tata McGraw Hill, 2010.

4	20MTP15	Advanced power plant cycle
4	**20MTP331**	**Experimental methods in thermal power Engineering**
4	20MTP321	Convertive Heat and Mass transfer
4	**20MMD332**	**Design Optimization**
4	20MMD323	Composite material Technology
4	**20MST333**	**Corrosion science and Technology**
4	20MTE322	Non science and Non martial
4	20MCM323	Reliability and Maintenance Engineering
4	20CAE331	Dynamics and Mechanism Design
4	20MSE322	Tool Design
4	20MPD324	Advanced fluid power system
4	20MTP333	Gas Dynamics
4	**20MAR252**	**Drives and control system for automation**

Group no.	**4**	Subject Code	20MTP15	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCED POWER PLANT CYCLES**				

Module-1

Analysis of Steam cycles: Rankine cycle, Carnot cycle, mean temperature of heat addition, effect of variation of steam conditio on thermal efficiency of steam power plant, reheating of steam, regeneration, regenerative feed water heating, feed water heaters carnotization of Rankine cycle, optimum degree of regeneration, Super critical pressure cycle, steam power plant appraisal Deaerator, typical layout of steam power plant, efficiencies in a steam power plant, Cogeneration of Power and Process Heat Numerical Problems. Combined cycle power generation: Flaws of steam as working fluid in Power Cycle, Characteristics o ideal working fluid in vapor power cycle, Binary vapor cycles, coupled cycles, combined cycle plants, gas turbine- steam turbin power plant, MHD-steam power plant, Thermionic- Steam power plant.

Module-2

Steam Generators: Basic type of steam generators, fire tube boilers, water tube boilers. Economizers, super heaters, re heaters, steam generator control, air preheater, fluidized bed boilers, electrostatic precipitator, fabric filters and bag houses, ash handling system, feed water treatment, de-aeration, evaporation, internal treatment, boiler blow down, steam purity, Numerical problems. Condenser, feed water and circulating water systems: Need of condenser, direct contact condensers, feed water heaters, circulating water system, cooling towers, calculations, Numerical Problems.

Module-3

Nuclear Power Plants: Chemical and nuclear reactions, nuclear stability and binding energy, radioactive decay and half-life, nuclear fission, chain reaction, neutron energies. Neutron flux and reaction rates, moderating power and moderating ratio, variation of neutron cross sections with neutron energy, neutron life cycle. Reflectors, Types of Reactor, PWR, BWR, gas cooled reactors. Liquid metal fast breeder reactor, heavy water and Fusion Power reactors. Safety in nuclear power plants.

Module-4

Hydro Electric Power Plant: Introduction, advantages and disadvantages of water power, optimization of hydro – thermal mix, hydrological cycles, storage and pondage Power plant Economics: Definitions, Principles, Location of power plant, cost analysis selection of type of generation, selection of power plant equipment's

Module-5

Pollution and its effects: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies. **Social Issues and the Environment:** Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.

Note: Visit to Power plant is desirable.

Course outcomes:
At the end of the course the student will be able to:

CO1: Distinguish the various power plant cycle and their working principles.

CO2: Describe the working principles of different components of power plant.

CO3: Explain the concepts of power generation by nuclear power plant.

CO4: Illustrate the concept of hydroelectric power generation.

CO5: Explain the concept of pollution and its effects.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

1. Power Plant Engineering - P.K. Nag, Tata McGraw-Hill Publications. 2nd edition

2. Power Plant Engineering - M.M. EI-Wakil, McGraw- Hill Publications. 1st edition

3. Power plant engineering –R.K.Rajput, Laxmi Publications 3rd edition

Group no.	**4**	Subject Code	20MTP331	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**EXPERIMENTAL METHODS IN THERMAL POWER ENGINEERING**				

Module-1

Basics of Measurements: Introduction, General measurement system, Signal flow diagram of measurement system, Inputs and their methods of correction. **Pressure measurement:** Different pressure measurement instruments and their comparison, Transient response of pressure transducers, dead-weight tester, low-pressure measurement.

Module-2

Thermometry: Overview of thermometry, temperature measurement by mechanical, electrical and radiation effects. Pyrometer, Thermocouple compensation, effect of heat transfer. **Thermal and transport property measurement:** Measurement of thermal conductivity, diffusivity, viscosity, humidity, gas composition, pH, heat flux, calorimetry, etc.

Module-3

Flow Measurement: Flow obstruction methods, Magnetic flow meters, Interferometer, LDA, flow measurement by drag effects, pressure probes, other methods. **Nuclear, thermal radiation measurement:** Measurement of reflectivity, transmissivity, emissivity, nuclear radiation, neutron detection, etc. Other measurements: Basics in measurement of torque, strain.

Module-4

Analysis of experimental data: Causes and types of errors in measurement, Propagation of errors, Uncertainty analysis, Regression analysis, Statistical analysis of Experimental data. **Sensing Devices:** Transducers-LVDT, Capacitive, piezoelectric, photoelectric, photovoltaic, Ionization, Photoconductive, Hall-effect transducers, etc.

Module-5

Air-Pollution: Air-Pollution standards, general air-sampling techniques, opacity measurement, sulphur dioxide measurement, particulate sampling technique, combustion products measurement. **Advanced topics:** Issues in measuring thermo physical properties of micro and Nano fluids. **Design of Experiments:** Basic ideas of designing experiments, Experimental design protocols with some examples and DAS.

Course outcomes:

At the end of the course the student will be able to:

- CO1: Understand the concepts of errors in measurements, statistical analysis of data, regression analysis, correlation and estimation of uncertainty.
- CO2: Describe the working principles in the measurement of field and derived quantities.
- CO3: Examine sensing requirements for measurement of thermo-physical properties, radiation properties of surfaces, and vibration.
- CO4: Understand conceptual development of zero, first and second order systems.
- CO5: Interpret International Standards of measurements (ITS-90) and identify internationally accepted measuring standards for measurands.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Modern Electronic Instrumentation and Measurement Techniques; Albert D Helfrick and William D Cooper, 2004, PHI.
2. b. Process Control: Principles and Applications; Surekha Bhanot, Oxford University press, Fourth Impression, 2010.
3. Instrumentation, Measurement and Analysis; BC Nakra, and KK Chaudhry; 2 ed, 2004, Tata McGraw-Hill
4. Transducers and Instrumentation; DVS Murthy, 2003, PHI
5. Instrumentation Devices and Systems; CS Rangan, GR Sarma, and VSV Mani; 2 ed, Tata McGraw-Hill
6. Measurement Systems Application and Design; Doeblin and Ernest; 5 ed, 2004, Tata McGraw-Hill.
7. Measurement Systems – Applications & design; Doeblin E.O. 4th ed. Mc. Graw Hill
8. Principles of Industrial Instrumentation, Patranabis D. TMH – 1997
9. Mechanical & Industrial Measurements, Jain R.K, Khanna Publishers – 1986
10. Process Instruments and control Hand book, Considine D.M, 4th ed, Mc.Graw Hill
11. Instrument Technology – Vol.1m, Jones E.B., Butterworths – 1981
12. Control Systems Engineering, Nagrath&M.Gopal, Wiley Eastern
13. Automatic Control Systems, B.C.Kuo, John Wiley, 2009
14. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall

Group no.	4	Subject Code	20MTP321	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**CONVECTIVE HEAT AND MASS TRANSFER**				

Module-1

INTRODUCTION TO FORCED, FREE & COMBINED CONVECTION – convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers. Equations of Convective Heat Transfer: Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

Module-2

EXTERNAL LAMINAR FORCED CONVECTION: Similarity solution for flow over an isothermal plate– integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate. External Turbulent Flows: Analogy solutions for boundary layer flows – Integral equation solutions Effects of dissipation on flow over a flat plate. **Internal Laminar Flows:** Fully developed laminar flow in pipe, plane duct & ducts with other cross sectional shapes – Pipe flow & plane duct flow with developing temperature field – Pipe flows & plane duct flow with developing velocity & temperature fields. Internal Turbulent Flows: Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

Module-3

NATURAL CONVECTION: Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

Module-4

COMBINED CONVECTION: Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal flows - internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

Module-5

CONVECTIVE HEAT TRANSFER THROUGH POROUS MEDIA: Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow – Natural convection in porous media – filled enclosures – stability of horizontal porous layers. **Convective Mass Transfer**: Basic Definitions and Formulation of a Simplified Theory, Evaluation of The Mass-Transfer Conductance, Examples for application of the Simplified Method.

Course outcomes:

At the end of the course the student will be able to:

- CO1 Understand the fundamental and advanced principles of forced and natural convection heat transfer processes.
- CO2 Formulate and solve convective heat transfer problems
- CO3 Relate the principles of convective heat transfer to estimate the heat dissipation from devices.
- CO4 Estimate the energy requirements for operating a flow system with heat transfer. CO5 Relate to the current challenges in the field of convective heat transfer.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Bejan, A., Convection Heat Transfer, John Willey and Sons, New York, 2001.
2. Louis, C. Burmeister, Convective Heat Transfer, John Willey and Sons, New York, 2003.
3. Kays, W.M. and Crawford, M. E., Convective Heat and Mass Transfer, McGraw Hill, New York, 2001

Group no.	4	Subject Code	20MMD332	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN OPTIMIZATION**				

Module-1

Engineering Design Practice: Evolution of Design Technology, Introduction to Design and the Design Process, Design versus Analysis, Role of Computers in Design Cycle, Impact of CAE on Design, Numerical Modeling with FEA and Correlation with Physical Tests.

Applications of Optimization in Engineering Design: Automotive, Aerospace and General Industry Applications, Optimization of Metallic and Composite Structures, Minimization and Maximization Problems, MDO and MOO.

Module-2

Optimum Design Problem Formulation: Types of Optimization Problems, The Mathematics of Optimization, Design Variables and Design Constraints, Feasible and infeasible Designs, Equality and Inequality Constraints, Discrete and Continuous Optimization, Linear and Non-Linear Optimization.

OptimizationTheory–Fundamental Concepts, Global and Local Minimum, Gradient Vector and Hessian Matrix, Concept of Necessary and Sufficient Conditions, Constrained and Unconstrained Problems, Lagrange Multipliers and Kuhn Tucker Conditions.

Module-3

Sensitivity Analysis: Linear and Non-Linear Approximations. Gradient Based Optimization Methods– Dual and Direct.

Optimization Disciplines: Conceptual Design Optimization and Design Fine Tuning, Combined Optimization, Optimization of Multiple Static and Dynamic Loads, Transient Simulations, Equivalent Static Load Methods. Internal and External Responses, Design Variables in Each Discipline.

Module-4

Manufacturability in Optimization Problems: Design for Manufacturing, Manufacturing Methods and Rules, Applying Manufacturing Constraints to Optimization Problems.

Design Interpretation: Unbound Problems, Over Constrained Problems, Problems with No of Multiple Solutions, Active and Inactive Constraints, Constraint Violations and Constraint Screening, Design Move Limits, Local and Global Optimum.

Module-5

Dynamic Programming: Introduction, Multistage decision processes, Principle of optimality, Computational Procedure in dynamic programming, Initial value problem, Examples.

Course outcomes:

At the end of the course the student will be able to:

CO1. Identify and apply relevant problem solving methodologies.

CO2. Design components, systems and/ or processes to meet required specification.

CO3. Optimize an existing design with single or multiple objective functions.

CO4. Apply decision-making methodologies to evaluate solutions for efficiency, effectiveness and sustainability

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. S.S.Rao, Engineering Optimization: Theory and Practice, John Wiley, 2009
2. Jasbir Arora, Introduction to Optimum Design, McGraw Hill, 2011.

Reference Books

1. Optimisation and Probability in System Engg-Ram, Van Nostrand.
2. Optimization methods -K. V. Mital and C. Mohan, New age International Publishers

Group no.	4	Subject Code	20MMD323	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**COMPOSITE MATERIALS TECHNOLOGY**				

Module-1

Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics &selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction
Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

Module-2

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths. Failure Criteria: Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsa-Hilltheory,Tsai,Wutensortheory,Numericalproblem,practicalrecommendations.

Module-3

Macro Mechanical Analysis of Laminate: Introduction, code, Kirchhoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation).

Module-4

Analysis of Composite Structures: Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures. Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.

Module-5

Manufacturing and Testing: Layup and curing - open and closed mould processing, Hand lay- up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injectionmoulding, Cutting, Machining, joiningand repair. NDT tests– Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

Course outcomes:

At the end of the course the student will be able to:
CO1. Understandtheuseoffibre-reinforcedcompositesinstructuralapplications.
CO2. Developabasicunderstandingoftheuseofcompositematerials,micro- mechanicsoflayeredcomposites,analysisanddesignof compositestructures and failure analysis of laminated panels.
CO3. Apply the basic micro-mechanics theories in the design of fibre reinforced composites.
CO4. Analyze the performance of composites in engineering applications

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Autar K. Kaw, Mechanics of Composite materials, CRC Press, 2nd Ed, 2005.
2. Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press,2004.

Reference Books

1. J.N.Reddy,MechanicsofLaminatedCompositePlates&Shells,CRDPress,2ndEd,2004.
2. Mein Schwartz, Composite Materials handbook, McGraw Hill, 1984.
3. Rober M. Jones, Mechanics of Composite Materials, Taylor & Francis, 1998.
4. MichaelW,Hyer,Stressanalysisoffiber ReinforcedCompositeMaterials,McGrawHill International, 2009.
5. CompositeMaterialScienceandEngineering,KrishanK.Chawla,Springer,3e,2012.
6. Fibre Reinforced Composites, P.C. Mallik, Marcel Decker, 1993.
7. Hand Book of Composites, P.C. Mallik, Marcel Decker, 1993

Group no.	4	Subject Code	20MST333	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**CORROSION SCIENCE AND TECHNOLOGY**				

Module-1

Definition of corrosion, corrosion damage, classification of corrosion, electrochemical aspects, electrochemical reactions, mixed potential theory, Electrode potential, Nernst equation. oxy-reduction potentials.

Module-2

Corrosion thermodynamics – Pourbaix diagrams; Polarization of the corrosion cell; Activation controlled kinetics and concentration polarization, Evans diagrams, partial corrosion reactions- anodic dissolution of metals; Cathodic reactions – oxygen reduction and hydrogen evolution.

Module-3

Corrosion of materials in natural environments; Atmospheric corrosion, general characteristics, mechanism and prevention; soil corrosion – general characteristics, mechanism and prevention. Localized corrosion damages and materials failure-passivity and transpassivity of metals, breakdown of passivity and pitting corrosion. Stress – corrosion cracking of materials. Inter-granular corrosion failure. Corrosion failure of ceramic materials; mechanisms of corrosion of ceramics, effect of chemical, phase composition and structure on corrosion resistance. Corrosion degradation of concrete.

Module-4

Tafel and linear polarisation, AC impedance, small-amplitude cyclic voltammetry. Paint tests, sea water tests. Interpretation of results, Corrosion prevention; materials selection, alteration of environment, design, cathodic and anodic protection coating.

Module-5

Environmental effects from the chemical processes industry (like Pulp mill operations, bleach plants, boilers, paper machine, water treatment plants in the pulp and paper industry and others), infrastructure, and transportation industry. Safety aspects. .

Course outcomes:

At the end of the course the student will be able to:

- Good knowledge of Corrosion Science.
- Assesment of its impact on its environment.
- Suggest the right technique
- Understand the safety aspects
- Prevent Environment degradation.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

Corrosion Science and Engineering (English, Hardcover, Pedeferri Pietro, Publisher: Springer International Publishing AG, 2016.

1. Mars G. Fontana, Corrosion Engineering, McGraw-Hill Book Company, 1986.
2. David Talbot and James Talbot, Corrosion Science and Technology, CRC Press, New York, 1998.
3. Denny A. Jones, Principles and Prevention of Corrosion, Maxwell Matemillar 1992.
4. D. A. Jones: Principles and Prevention of Corrosion, Macmillan Publ. Co. (1996).
5. 2. C. Scully: The Fundamental of Corrosion, 2nd ed., Pergamon Press: E. Stansbury and R. A. Buchanan, Fundamentals of Electrochemical Corrosion, ASM International (2000).
6. 3. M.G. Fontana: Corrosion Engineering, 3rd. Ed., McGraw Hill. (1986)
7. 4. J. M. West: Electrodeposition and Corrosion Control, J. Wiley W. Revie (ed.):
8. Corrosion Handbook, Electrochemical Society Series, John Wiley and Sons (2000).
9. 5. W. Revie (ed.): Corrosion Handbook, Electrochemical Society Series, John Wiley and Sons, 2000: Metals Handbook, Vol. 13: Corrosion, ASM International

Reference Books

1. Fontana, Mars G, Advances in corrosion science and technology vol 6. 2012
2. Landolt, Dieter, Corrosion and surface chemistry of metals -- 2007
3. Uhlig, Herbert, Corrosion and corrosion control – 4th edn,1984.

Group no.	4	Subject Code	20MTE322	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**NANO SCIENCE AND NANOMATERIALS**				

Module-1

Introduction to Nano science and Nano tehnology: History, background scope and interdisciplinary nature of nano science and nanotechnology, scientific revolutions, nano sized effects surface to volume ratio, atomic structure, molecules and phases, energy at the nano scale molecular and atomic size, quantumeffects,types of nanotechnology and nano machines.

Classification of Nano structures: Zero dimensional, one-dimensional and two dimensional nanostructure materials-clusters of metals, semiconductors, ceramics and nano composites, size dependent phenomena, quantum dots nano wires, tubes, nanosheets, nano and mespores, top down and bottom ups approachs, misnomers and misconception of nano techonology, importance of nano scale materials and their devices.

Module-2

Properties of Nano materials: Mechanical properties- Thermo physical properties - Electrical properties – Electro chemical properties Magnetic p properties - optical properties -Catalytic property – properties of gas permeation and separation membranes.

Nanostructure Design: Functionality of nanostructures and their characteristics evaluation, size effect in semiconductor nano particles – particle size, shape density – Melting point, surface tension, wettability – specific surface area and pore – Assembly of nano particles and fictionalization – nano particles arranged structure s as nani pores and nano composites – Structure control of nano particle collectives by sintering and bounding – Self – assembly. Nano particle dispersion and aggression behaviour – Single nano particle motion in fluid – Brownian diffusion – Adsorption properties – interactions between particles – Aggregation and dispersion, characterization and control– Rheology of slurry – Simlation of colloidal dispersion system.

Module-3

Melting Point and Phase Transition Processes : quantum-size-effect (QSE) Size-induced metal-insulator-transition (SIMIT) nano-scale magnets, transparent magnetic materials and ultrahigh-density magnetic recording materials – chemical physical of atomic and molecular clusters. Surface energy – chemical potential as a function of surface curvature – Electrostatic stabilization – surface charge density-electric potential at the proximity of solid surface-vander Waals attraction potential. Photochemistry, Photoconductivity, Electrochemistry of nano materials – Diffusion in Nano materials, Nano scale Heat transfer, Catalysis by Gold Nano particles, Transport in semiconductor Nanostructures, Transition Metal Atoms on Nano carbon Surfaces, Nano deposition of soft materials, Nano catalysis.

Module-4

Application of Quantum Dots for Bio-Medical Engineering: Bio- imaging with quantum dots – Pinpoint drug and gene delivery- delivery to the brain – Development of the thermo responsive magnetic nano particle and its deployment in the biotechnology field, Addressing of nano particles by using DNA molecules, Nano particle formation of DNA (globule transformation) – Development and multi-functionalization of high – functional separation membranes – Design of nano particles for oral delivery of peptide drugs.

Module-5

Smart Materials And Systems : Thermo responsive materials, piezoelectric materials, electro strictive and magneto strictive materials, ferro fluids, ER and MR fluids, biomimetic materials, smart gel, shape memory alloys and polymers, actuation methods, measurements.

Nanoparticles: Surface modification of inorganic nano particles by organic functional groups Instantaneous nano foaming method for fabrication of closed –porosity silica particle- Development of photo catalyst inserted into surface of porous alumina silicate- Fabrication technique of organic nano crystals and their optical properties and matetialization, Dispersion control of nano particles in solvents – Development of new cosmetics based on nano particles – Development of functional skincare cosmetics using biodegradable PLGA nano spheres.

Course outcomes:

At the end of the course the student will be able to:

1. Students will be able to understand the importance of nanoscience and nanomaterials in industrial applications.
2. Understanding the basic properties and designs of nano structures.
3. Understanding the phase transition process.
4. Knowledge of Nano materials in Bio-Medical engineering.
5. Knowledge of Smart materials and its systems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Nanophysics and Nanotechnology" – An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf. 2nd Edition, John Wiley & Sons, 2006.
2. Surface Science Foundation of Catalysis and Nano science, K.W. Kolasinski, Wiley, 2002
3. Nano chemistry:- A chemical approach to Nano materials, G.A. Ozin and A.C. Arsenault 2005.
4. Nano structures & Nano materials Synthesis, Properties & applications, G. Cao Imperial Collage 2004.

Reference Books

1. Nano particulates as Drug Carriers imperial college Valdimir P, Torchilin (2006).
2. Nano materials and Nano systems for Bio-Medical Applications, M Reza Mozafari (2007), springer.
3. Nanotechnology – Basic science and emerging technologies Chapman and Hall/CRC(2002).
4. Nanomaterials and Nanotechnologies and design on introduction for engineers and architects, Micheal F. Ashby, P.J. Ferreria, D.L. Sehodek.

Group no.	**4**	Subject Code	20MCM323	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**RELIABILITY AND MAINTENANCE ENGINEERING**				

Module-1

Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Reliability – Cost trade off, Prediction and analysis, Problems.

Module-2

Maintainability, Availability & Failure Analysis: Introduction, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability and analysis. Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

Module-3

Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

Module-4

Maintenance Systems: Fixed time maintenance, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terotechnology.

Module-5

Mechanical Fault Diagnosis by Condition Monitoring Techniques: Thermography, Radiography, Ferrography, Acoustic emission monitoring, Noise monitoring. On line monitoring and diagnostic systems. Condition monitoring in power plants, chemical plants and petrochemical plants.

Course outcomes:

At the end of the course the student will be able to:

- Describe various methods of reliability to predict maintenance requirements and cost effectiveness.
- Predict and analyze the failure and maintenance requirement using various techniques
- Plan the schedule the maintenance with minimum breakdown time
- Apply various tool and techniques monitor the condition of the equipment
- Describe case studies related to condition monitoring of various manufacturing and process engineering systems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Optimization theory & Applications/ S.S Rao/ New Age International

(2) Introductory to operation research/Kasan& Kumar/ Springar

(3) Optimization Techniques theory & practice/M.C Joshi, K. M. Moudgalya/ Narosa Publications.

(4) Operation Research/H.A. Taha /TMH

Reference Books

(1) Optimization in operations research/R.L Rardin.

(2) Optimization Techniques/Benugundu & Chandraputla/Person Asia.

(3) Optimization Techniques /Benugundu & Chandraputla / Pearson Asia.

Group no.	**4**	Subject Code	20CAE331	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DYNAMICS AND MECHANISM DESIGN**				

Module-1

Geometry of Motion: Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, unique mechanisms.

Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method, Numerical examples.

Module-2

Generalized Principles of Dynamics: Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum.

Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations, Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamiltons equations, Numerical examples.

Module-3

Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle. Numerical examples.

Module-4

Graphical Methods of Dimensional Synthesis: Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages.

Ana1ytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.

Module-5

System Dynamics: Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances.

Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles. Numerical examples.

Course outcomes:

At the end of the course the student will be able to:

CO1. Apply the tools of analytical dynamics with the main goal of developing mathematical models that describe the dynamics of systems of rigid bodies.

CO2. Formulate equations of motion for complicated mechanical systems /linkages and hods for solving these equations.

CO3.Understand multi body dynamics in mechanical engineering design

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. K.J.Waldron&G.L.Kinzel , "Kinematics, Dynamics and Design of Machinery", Wiley India, 2007.
2. Greenwood, "Classical Dynamics", Prentice Hall of India, 1988.

Reference Books

1. J E Shigley, "Theory of Machines and Mechanism" -McGraw-Hill, 1995
2. A.G.Ambekar , "Mechanism and Machine Theory", PHI, 2007.
3. Ghosh and Mallick , "Theory of Mechanism and Mechanism", East West press

Group no.	**4**	Subject Code	20MSE322	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**TOOL DESIGN**				

Module-1

Tool-design Methods: Introduction, the design procedure, drafting and design techniques in tooling drawing

Tool-making Practices: Introduction, tools of the tool maker, hand finishing and polishing, screws and dowels, hole location, jig-boring practice, installation of drilling bushings, punch and die bushings, punch and die manufacture, EDM, EDM for cavity applications, tracer and duplicating mills for cavity applications, low-melting tool materials. **08 Hrs**

Module-2

Tooling Materials and Heat Treatment: Introduction, properties of materials, ferrous tooling materials, non-ferrous tooling materials, non- metallic tooling materials, heat treatment and tool design.

Design of Cutting Tools: Introduction, the metal cutting process, revision of metal cutting tools-single point cutting tools, milling cutters, drills and drilling, reamers, taps. Selection of carbide tools, determining the insert thickness for carbide tools.

08 Hrs

Module-3

Design of Tools for Inspection and Gauging: Introduction, work piece quality criteria, principles of gauging, types of gages and their applications, amplification and magnification of error, gage tolerances, selection of material for gages, indicating gages, automatic gages, gauging positionally tolerance parts, problems.

Locating and Clamping Methods: Introduction, basic principle of location, locating methods and devices, basic principle of clamping.

08 Hrs

Module-4

Design of Drill Jigs: Introduction, types of drill jigs, general considerations in the design of drill jigs, drill bushings, methods of construction, drill jigs and modem manufacturing.

Designof Fixtures: Introduction, types of fixtures, fixtures and economics.

Design of Press-working Tools: Power presses, cutting operations, types of die-cutting operations - and their design, evolution of blanking and progressive blanking. **08 Hrs**

Module-5

Design of Sheet Metal Bending, Forming and Drawing Dies: Introduction, bending dies, forming dies, drawing dies. Evolution of a draw die, progressive dies and selection of progressive dies. Strip development for progressive dies, evolution of progressive dies, examples of progressive dies. Extrusion dies, drop forging dies and auxiliary tools, problems.

Tool Design for Joining Processes: Introduction, tooling for physical joining processes, tooling for soldering and brazing, tooling for mechanical joining processes, problems. **08 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the tool design concept and design the single point cutting tool.
2. Design the mill cutters, broach and clamping devices.
3. Understand the application of jigs and fixtures, gauges and design them.
4. Understand the concept of press tools and its dies.
5. Design forming dies and understand the classification and application of automats.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) **Tool Design** - Cyril Donaldson, GH Lecain and VC Goold - TMH Publishing Co Ltd., New Delhi, - 3rd editions, 2000.

(2) **Fundamentals of Tool Design** – ASTME - PHI (P) Ltd., New Delhi -1983.

Reference Books

(1) **Cutting Tool Design** - Rodin - Mir publications -1968.

(2) **Metal cutting & Tool Design** - Arshinov -Mir Publishers , Moscow – 1970.

(3) **Press working of metals** – Hinman -McGraw Hill – 1950.

Group no.	**4**	Subject Code	**20MPD324**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCED FLUID POWER SYSTEMS**				

Module-1

Introduction: Pascal Law, Advantages of Fluid Power, Applications of Fluid Power, Components of a FluidPower.
Hydraulic Power Unit: Introduction, Pumping Theory, Pump Classification, Gear Pumps, (Vane Pumps- simple, balanced & pressure compensated vane pump, Vane design) Piston Pumps- Radial, Axial (Bent axis & Swash plate), Pump Performance, Pump Noise, Ripple in pumps.
Hydraulic Actuators: Linear actuator- cylinders, Mechanics of Hydraulic cylinder loading, limited rotation hydraulic actuator, cylinder cushioning, Gear, Vane & Piston motor, Motor performance, Hydrostatic transmission.**08Hrs**

Module-2

Power Controlling Elements – Valves :
i) Directional Control Valves – Classification, 2/2, 3/2,4/2 & 4/3 ways Dcv's, Different Centre configurations in 4/3 way valves, actuation of DCV's, Indirect actuation, Valve Lap – Lap during Stationary and duringswitching.
ii) Pressure Control Valves: Classification, opening & Closing Pressure difference, Cracking Pressure, Pressure Relief Valve – Simple & Compound type, Pressure reducing valve, sequence, unloading &Counter balance valve, Pressureswitches.
iii) Flow Control valves – Fixed throttle, Variable throttle, Pressure Compensation principles, pressure compensated Flow control valve – Reducing & Relieftype.
iv) Check valve, Pilot operated checkvalve. **08Hrs**

Module-3

Hydraulic Circuit Design & Analysis: Control of Single & double acting cylinder, Regeneration circuit, cylinder sequencing & Synchronizing circuit. Speed control of cylinder & Motors, Analysis of Hydraulic system with frictional losses, Accumulators &accumulator circuits.
Pneumatic System: Introduction, – Generation of compressed air, air receiver, servicing FRL unit, Air filter, pressure regulation, lubricator, Pneumatic cylinder & air motor – different types of cylinder, cushion assembly. Cylinder performance.
Pneumatic Valve: Directional control valves, impulse valve, Quick exhaust valve, shuttle valve, Twin pressure valve, Time delay valve. **08Hrs**

Module-4

Pneumatic Circuit & Logic Circuits:- Control of single and double acting cylinder, impulse operation, speed control, sequencing, Pneumatic Vacuum system AND,OR, NOT, NAND, NOR, YES Function, Logic circuits design using shuttle valve & twin pressure valve, Binary Arithmetic, logic & Boolean Algebra, use of kannaughveitch map for pneumatic circuit design.
08Hrs

Module-5

Electrical Control in Fluid Power: Contactors, & Switches, Relays, Limit switch, Electro hydraulic & Electro Pneumatic Circuits, Simple Cylinder reciprocation, interlocking using relays, Proximity switches, application of proximity switches, Time dependent will dependent and travel dependent circuits. **08Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. Explain the working principle and performance parameters of various hydraulic and pneumatic components andsystems.
2. Design hydraulic and pneumatic circuits for mechanical engineering applications.
3. Analyze performance evaluation of fluid power systems and propose improvements.
4. Understand the Control of single and double acting cylinder, impulse operation, speed control, sequencing, Pneumatic Vacuum system AND,OR, NOT, NAND, NOR, YESFunctions.
5. Analysethe Electrical Control in Fluid Powersystems.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbooks

(1) Fluid Power with ApplicationAnthonyEspositoPeason Education 5th edition

(2) Oil hydraulics -Principles &maintenanceS.R. MajumdarTata M C Graw Hill

Reference Books

(1) Components &ApplicationBosch Rexroth didacticHydraulicsTrainervol 1

(2) Pneumatic System, Principles and MaintenanceS.R. MajumdarTata M C Graw Hill

(3) Pneumatics: Theory and Applications

(4)ElectroPneumaticsBosch Rexroth didacticVol. 2

Group no.	**4**	Subject Code	20MTP333	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**GAS DYNAMICS**				

Module-1

Fundamental equations of steady flow: Definition of Compressible Flow, Flow Regimes, Continuity and momentum equation and energy equation. **Isentropic flow:** Acoustic velocity, Mach number, Mach cone and Mach angle. Flow parameters, stagnation temperature, pressure and density.

Module-2

Variable area flow: Velocity variation with Isentropic flow, Criteria for acceleration and deceleration. Flow through nozzle, Effect of pressure ratio on Nozzle operation. Convergent nozzle and convergent divergent nozzle. Effect of back pressure on nozzle flow. Isothermal flow functions and Flow Generalised one dimensional flows.

Module-3

Flow with normal shock waves: Development of shock wave, Rarefaction wave, Governing equations, Prandtl-Meyer relation, Mach number downstream, Static pressure rise, Density ratio, Temperature ratio, Tables and charts for normal shock.

Module-4

Flow with oblique shock waves: Fundamental relations, Prandtl's equation, Rankine- Hugoniot equation, Variation of flow parameters and Gas tables for oblique shocks. Over-expanded and under expanded flows.

Module-5

Flow in constant area with heat transfer: Stagnation temperature change. Rayleigh line, Pressure ratio and temperature ratio, Entropy considerations and maximum heat transfer. Flow in constant area with friction: Fanno curves, The fanning equation, Friction factor and frictionparameter, Fanno line and Fanno flow equations.

Course outcomes:

At the end of the course the student will be able to:

- CO1: Apply continuity, momentum and energy equations to compressible flows.
- CO2: Analyze isentropic and non-isentropic flows across normal shock waves.
- CO3: Solve compressible flow problems involving heat transfer and friction.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Fundamentals of Compressible flow: Yahya, 2nd Edn. 1991; Wieley Eastern.
2. Gas Dynamics, E Radhakrishnan PHI-2006
3. Gas Dynamics, Becker, Academic Press. Inc.

Reference Books

1. Introduction to Gas Dynamics: Rolty, wiley 1998
2. Elements of Gas Dynamics: Liepmann and roshko, Wiley 1994.
3. The dynamics and thermodynamics of compressible fluid flow: Shapiro Ronold press. 1994.

4. Modern Compressible Flow, Anderson John D, McGraw Hill Publication, 1990.

E-Books:

1. Gas Dynamics, E Radhakrishnan PHI (Kindle Edition)

2. Modern compressible flow, Anderson John D, McGraw Hill (Kindle Edition)

Group no.	**4**	Subject Code	20MAR252	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DRIVES AND CONTROL SYSTEMS FOR AUTOMATION**				

Module-1

Introduction: Working principle of synchronous, Asynchronous & stepper motors, Difference between Induction and servo motors, Torque v/s speed characteristics, Power v/s. Speed characteristics, Vector duty induction motors, Concepts of linear and frameless motors, Selection of feedback system, Duty cycle.

Module-2

Industrials Drives: DC and AC motors operation and selection, method of control and application of brushless DC motor, PMSM, stepper motor, A.C servomotor, selection criteria for servo motor and servo amplifier, universal motor, electric drive, types of industrial drives, the characteristics of drive, advantages of drives over other prime movers, motor rating, heating effects.

Module-3

Motion Laws For Rotary And Linear Systems: converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley, chain drives, gear drives, Selection of converting systems, Dynamic response gearing, and control approaches of Robots, Control loops using Current amplifier

Module-4

Introduction to Programmable Logic Controllers: Definitions of PLC, basic structure of PLC, working principles, data storage methods, inputs / outputs flag processing's, types of variables, definition of firmware, software.

Module-5

Logic, Instructions & Application of PLC: What is logic, Conventional Ladder v/s PLC ladder, series and parallel function of OR, AND, NOT logic, Ex Or logic, Analysis of rung. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Sequencer instruction, Visualization Systems.

Course outcomes:

At the end of the course the student will be able to:

- Understand the basics of Electric drives
- Explain industrial processes and selection of drives
- Differentiate various control systems
- Develop motor control circuits
- Illustrate computer based industrial control
- Describe Electric traction

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1)	Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8th edition Andrew Parr, Industrial drives, Butterworth – Heineamann
(2)	Andrew Parr, Industrial drives, Butterworth – Heineamann
(3)	G.K. Dubey. Fundamentals of electrical drives
(4)	Programmable Logic Controllers by W.Bolton
Reference Books	
(1)	Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-
(2)	Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
(3)	A.E. Fitzerald , C. Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Student edition
(4)	S.K. Pillai. A First course on electric drives –Wiley Eastern 1990
(5)	Programmable Logic Controllers by Hugh Jack.

5	**20MPE31**	**Theory of metal forming**
5	**20MPM13**	**Lean Manufacturing System**
5	**20MEM252**	**Product Life Cycle Management**
5	20MTP241	Engineering conservation and management
5	20MTP254	Jet Propulsion and Rocketry
5	**20MTP324**	**Phase change phenomena in fluids**
5	20MMD321	Mechatronics system Design
5	**20MMD331**	**Smart Material and Structures**
5	**20MST323**	**Non- traditional machining**
5	**20MTE251**	**Product Design technology**
5	**20MAR251**	**Networking and IOT**
5	20CAE243	Vehicle Aerodynamics
5	20MSE23	Advanced processing of materials
5	20MEM321	Industrial Marketing
5	20MPE13	Advanced Foundry Technology
5	20MTE331	Design for Manufacture
5	20MCM243	Metrology and computer Aided Inspection

Group no.	**5**	Subject Code	20MPE31	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**THEORY OF METAL FORMING**				

Module-1

Introduction to Forming process: Introduction to metal forming, Effect of temperature on forming process-hot working, cold working. Effect of Metallurgical structure, Effect of speed of deformation work of Plastic deformation, Friction in forming operation.

10 Hrs

Module-2

Forging: Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging.

10 Hrs

Module-3

Rolling of Metals: Classification, forces and geometrical relationships in rolling.

Variables in Rolling: Deformation in rolling, Defects in rolled products, Residual stresses in rolled products. Torque and Horsepower.

10 Hrs

Module-4

Extrusion: Classification, Extrusion equipment, variables in extrusion, Deformation in extrusion, Extrusion defects, Work done in extrusion.

Drawing: Principles of Rod and wire drawing, variables in wire drawing, Residual stresses in rod, wire and tube drawing, Defects in Rod and wire drawing.

10 Hrs

Module-5

Sheet Metal Forming: Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products.

10 Hrs

Course outcomes:

At the end of the course the student will be able to:

1. Understand the basics of metal forming.
2. Recognize the importance of metal forging using different geometrical shapes and various defects.
3. Understanding the concept of rolling ,types of rolling mills and processes and its defects
4. To understand the concepts of extrusion and drawing and their applications.
5. To understand the types of sheet metal forming processes and HERF

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

(1)**Mechanical MetalIurgy** - Dieter G.E. - Mc Graw Hill Publications.

(2) **Principles of Metal Working** - R.Rowe - Amold London – 1965.

(3)**Metals Handbook** – ASM - Volume II -.ASM

Group no.	**5**	Subject Code	**20MPM13**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**LEAN MANUFACTURING SYSTEMS**				

Module-1

Just in time production system. JIT Logic -Pull system Japanese approach to production elimination of waste - JIT implementation requirements JIT application for job shops, Case studies.

10 Hrs

Module-2

Kanban system:-Kanban rules supplier Kanban and sequence schedule used by supplier. Monthly information & daily information. Later replenish system by Kanban sequenced withdrawal P system by sequence schedule table - problems & counter measures in applying Kanban system to subcontractors - Supplier Kanban circulation in the paternal manufacturer - structure of supplier Kanban sorting office.

10 Hrs

Module-3

The rise of lean production: - Birth place, concrete example, company as community, Final assembly plant, product development and engineering. Changing customer demand, dealing with the customer, future of lean production.

Shortening of production lead times: reduction of setup times, practical procedures for reducing setup time.

10 Hrs

Module-4

Standardization of operations: Machine layout, multi function workers and job rotation. Improvement activities to reduce work force and increase worker morale -foundation for improvements.

Elements of lean production viz G M Framingharn: Toyota Takaoka Mass Production V /s lean production, diffusing lean production.

10 Hrs

Module-5

Managing lean enterprise:-Finance, Career ladders, geographic spread and advantages of global enterprise.

Prospects for catching up. Simplicity in the natural state: institutional factors -life time employment - educational commodities -quality & productivity in full circle.

10 Hrs

Course outcomes:

At the end of the course the student will be able to:

1. To understand issues & challenges in implementing & developing lean manufacturing techniques from TPS & its contribution for improving organizational performance.
2. Apply lean techniques to bring competitive business culture for improving organization performance .
3. Analyze how lean techniques can be applied to manufacturing & service industry
4. Developing lean management strategy for Supply chain management.
5. Analyzing how lean technique can create value generation for organization

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books

1. Productions and Operations Management-ChaselAquilino– Dreamtechlatestedition.

2. Toyoto Production System -An integrated approach to Just in Time – YasuhiroMonden - Engineering aild Management Press -Institute of Industrial EngineersNorcross Georgia -1983.

3. The Machine that changed the World. The Story of Lean Production
- James PWomack - Daniel TJones - and Daniel Roos -Harper Perennial – editionpublished 1991.

Group no.	**5**	Subject Code	**20MEM252**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**PRODUCT LIFE CYCLE MANAGEMENT**				

Module-1

Product life cycle management – Need for PLM, Components of PLM, Product Data and Product workflow, Drivers for Change, The PLM Strategy, Developing a PLM Strategy, a Five-step Process**10HRs**

Module-2

Strategy Identification and Selection, Strategy Elements, Implications of Strategy Elements, Policies, Strategy Analysis, Communicating the Strategy. **10HRs**

Module-3

Change Management for PLM, Configuration management, and cost of design changes, schemes for concurrent engineering, Design for manufacturing and assembly,robustdesign. **10HRs**

Module-4

Modeling, Current concepts, part design, sketching, use of datum's construction features, free ovulation, pattering, copying, and modifying features, reference standards for datum specification, Standards for Engineeringdataexchange. **10HRs**

Module-5

Tolerance mass property calculations, rapid prototyping and tooling, finite modeling and analysis, general procedure, analysis techniques, Finite element modeling. Applicability of FEM, Static analysis, dynamicanalysis. **10HRs**

Course outcomes:

At the end of the course the student will be able to:

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDMimplementation.
2. Illustrate various approaches and techniques for designing and developingproducts.
3. Apply product engineering guidelines / thumb rules in designing products for molding, machining, sheet metal workingetc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturingplan
5. Understand the Tolerance mass propertycalculations.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbooks

(1) **Product Lifecycle Management Paradigm for century Product Realization** - John Stark, Springer-Verlag, **21st**, London, 3rd printing - 2006. 441 pp., ISBN: 1-85033-810-5

(2) **CAD/CAM Theory and Practice** -Zeid, McGraw Hill.- 1991

Reference Books

(1) **Computer Integrated Design and Manufacturing**, - Mark Henderson & Philip Wolfe, Bedworth McGraw hill inc.- 1991

(2) **Part modeling Users Guide**, Engineer - I998

Group no.	**5**	Subject Code	20MTP241	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ENERGY CONSERVATION AND MANAGEMENT**				

Module-1

Energy Conservation: Introduction - Indian Energy Conservation Act - List of Energy Intensive Industries - Rules for Efficient Energy Conservation - Identification of Energy Conservation opportunities - Technologies for Energy Conservation – Energy Conservation Schemes and Measures - Energy flow networks - Critical assessment of energy use - Optimizing Energy Inputs and Energy Balance - Pinch Technology.

Module-2

Energy Efficiency Improvement: Steam Generation - Distribution and Utilization –Furnaces - Fans and Blowers - Compressors Pumps - Pinch Technology - Fluidized bed Combustion - Heat Exchanger Networks - Case Studies - Analysis and recommendation.

Module-3

Energy Audit: Definition and Concepts, Types of Energy Audits – Basic Energy Concepts –Energy audit questionnaire, Data Gathering – Analytical Techniques. Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria, Economic Analysis: Scope, Characterization of an Investment Project – Types of Depreciation –Time Value of money – budget considerations, Risk Analysis. Introduction to SCADA software.

Module-4

Energy Efficient Lighting: Terminology - Laws of illumination - Types of lamps -Characteristics - Design of illumination systems - Good lighting practice - Lighting control- Steps for lighting energy conservation. Lighting standards.

Module-5

Economics of Generation and Distribution: Generation: Definitions - Connected load, Maximum demand - Demand factor –Diversity factor – Significance - Power Factor – Causes and disadvantages of low power factor – Economics of power factor improvement. Distribution: Electrical load analysis - Types of consumers & tariffs - Line losses -Corona losses - Types of distribution system - Kelvin's law - Loss load factor – Green Labeling – Star Rating.

Course outcomes:
At the end of the course the student will be able to:

- **CO1:** Understand the various energy conservation and improvement techniques.
- **CO2:** Illustrate the Energy scenario.
- **CO3:** Employ the principles of thermal engineering and energy management to improve the Performance of thermal systems.
- **CO4:** Assess energy projects on the basis of economic and financial criteria.
- **CO5:** Describe methods of energy production for improved utilization

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
4. Smith, C. B., Energy Management Principles, Pergamon Press, 2007

Group no.	**5**	Subject Code	20MTP254	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**JET PROPULSION AND ROCKETRY**				

Module-1

PRINCIPLES OF JET PROPULSION AND ROCKETRY: Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines. Nozzle Theory and Characteristics Parameters: Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, Ac / At of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

Module-2

AERO THERMO CHEMISTRY OF THE COMBUSTION PRODUCTS: Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows. Solid Propulsion System: Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates

Module-3

SOLID PROPELLANT ROCKET ENGINE: internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer Thermal Engineering considerations in solid rocket motor design. Ignition system, simple pyro devices. Liquid Rocket Propulsion System: Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

Module-4

TURBO JET PROPULSION SYSTEM: Gas turbine cycle analysis –layout of turbo jet engine. Turbo machinery-compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis. Flight Performance: Forces acting on vehicle – Basic relations of motion – multi stage vehicles

Module-5

RAMJET AND INTEGRAL ROCKET RAMJET PROPULSIONSYSTEM: Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

Course outcomes:
At the end of the course the student will be able to:

CO1: Understand the aero thermo chemistry of the combustion products.
CO2: Apply concepts to Rocket Engine
CO3: Apply the concepts to ramjet ant jet propulsion system.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1 Mechanics and Dynamics of Propulsion/ Hill and Peterson/John Wiley& Sons

2. Rocket propulsion elements/Sutton/John Wiley & Sons/8th Edition

Reference Books

1. Gas Turbines/Ganesan /TMH

2. Gas Turbines & Propulsive Systems/Khajuria & Dubey/Dhanpat Rai& Sons

3. Rocket propulsion/Bevere

4. Jet propulsion /Nicholas Cumpsty

Group no.	**5**	Subject Code	20MTP324	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**PHASE CHANGE PHENOMENA IN FLUIDS**				

Module-1

Fundamentals: Thermodynamic Equilibrium of Binary and Multi-component mixtures: Fugacity and Fugacity Coefficient of Pure Substance and Mixture, Gibbs Phase Rule. **Binary Mixtures:** Phase Equilibrium Diagrams for Binary Mixtures, Ideal Mixtures, Numerical on phase diagrams of ideal mixtures, Raoult's law of mixture, Zeoptrope and Azoetrope mixture Basic Equations on two phase flow: Mass, Momentum and Energy.

Module-2

Pool Boiling: Boiling regimes, Dimensional Analysis, Nucleate boiling of ordinary fluids, Numerical on nucleate boiling, Film boiling of ordinary fluids, Passive and Active enhancement techniques in heat transfer enhancement.

Module-3

Flow boiling: Boiling regimes in Horizontal and vertical flow, Nucleate boiling in flow, Saturated boiling in flow, Film boiling in flow, Flow boiling for binary mixtures and Augmentation techniques inflow boiling.

Module-4

Flow Patterns and Bubble Dynamics: Flow pattern in Horizontal and vertical tubes: Bubbly flow, plug flow, Stratified flow, Wavy flow, Slug flow and Annular flow. Two phase flow instability: Taylor and Helmholtz instabilities Homogenous and Heterogeneous Nucleation, Rayleigh-Plesset Equation, Bubble Nucleation site density, Bubble size, Bubble departure, Bubble waiting period, Bubble departure and Simple Numerical.

Module-5

Condensation: Film wise condensation: Laminar condensation of vapour, Condensation on tube banks and Numerical. Drop wise Condensation: Condensation of steam-Factors effecting.

Course outcomes:
At the end of the course the student will be able to:

- CO1: Solve for temperature, pressure and enthalpy of Binary mixtures.
- CO2: Solve the basic equations to determine velocity, pressure and temperature of multiphase flow.
- CO3: Analyse pool and flow boiling phenomena to design the heat dissipative cooling equipment.
- CO4: Understand different flow pattern and its instability with bubble behavior
- CO5: Analyse condensation phenomena in the industrial and commercial equipment.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks
1. Convective boiling and condensation by John G. Collier and John R. Thome, Third edition, Oxford Science Publication.
2. Boiling heat transfer and Multiphase flow by L.S Tong, Second edition, Taylor and Francis Publication.
3. Hand book of Phase Change in Boiling and Condensation by Sathish G. Kandlikar by Taylor and Francis
Reference Books
1. Fundamentals of Multiphase Flows by Christopher E. Brennen, Cambridge University Press 2005.
E Books/Web references
1. https://nptel.ac.in/courses/103105058/ 2. https://nptel.ac.in/courses/112107207/

Group no.	**5**	Subject Code	20MMD321	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MECHATRONICS SYSTEM DESIGN**				

Module-1
Introduction: Definition and introduction to Mechatronic Systems. Modelling & Simulation of physical systems. Overview of Mechatronic products and their functioning. Measurement systems, control systems, simple controllers. Study of sensors and transducers, Pneumatic and Hydraulic Systems, Mechanical actuation systems, Electrical actuation systems, Real time interfacing and hardware components for Mechatronics.
Module-2
Electrical Actuation Systems: Electrical systems, mechanical switches, solid state switches, solenoids, DC & AC motors, Stepper motors. System Models: Mathematical models, mechanical system building blocks, electrical system building blocks, thermal system building blocks, electro-mechanical systems, hydro-mechanical systems, pneumatic systems.
Module-3
Signal Conditioning: Signal conditioning, the operational amplifier, protection, filtering, Wheatstone bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, Pulse-modulation. MEMS and Micro systems: Introduction, working principle, materials for MEMS and Micro systems, Micro system fabrication process, overview of Micro Manufacturing, Micro system Design, and Micro system packaging.
Module-4
Data Presentation Systems: Basic System Models, System Models, and Dynamic Responses of System.
Module-5
Advanced Applications in Mechatronics: Fault Finding, Design arrangements and practical case studies, Design for manufacturing, User- friendly design
Course outcomes: At the end of the course the student will be able to: CO1. Describe mechatronic systems and overview of control systems & actuators. CO2. Identify and describe the different types of actuators used in mechatronic systems. CO3. Differentiate between various sensors, transducers and actuators and their applications. CO4. Identify and describe the different types of speed- and position feedback devices. CO5. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers. CO6. Discuss the importance of feedback in controlling physical systems with the use of examples. CO7. Explain the principle of operation of ac induction motor, dc motor, servomotor and stepper motor. CO8. Identify and describe the types of controllers used in mechatronic systems.
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■
Textbook/ Textbooks

1 W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999 2. HSU “MEMS and Microsystems design and manufacture” - Tata McGraw-Hill Education, 2002

Reference Books

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics” - IEEE Press, 1 Edition, 1996
2. Shetty and Kolk “Mechatronics System Design” - Cengage Learning, 2010
3. Mahalik “Mechatronics” - Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics” - Tata McGraw-Hill Education, 1998
5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”– . Mc Grew Hill, 2002
6. “Fine Mechanics and Precision Instruments” - Pergamon Press, 1971.

Group no.	**5**	Subject Code	20MMD331	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**SMART MATERIALS AND STRUCTURES**				

Module-1

Smart Structures: Types of smart structures, potential feasibility of smart structures, key elements of smart structures, applications of smart structures. Piezoelectric materials, properties, piezoelectric constitutive relations, depoling and coersive field, field strain relation. Hysteresis, creep and strain rate effects, inchworm linear motor. Beam modeling: Beam modeling with induced strain rate effects, inchworm linear motor beam modeling with induced strain actuation-single actuators, dual actuators, pure extension, pure bending harmonic excitation, Bernoulli-Euler beam model, problems, piezo-electrical applications.

Module-2

Shape memory Alloy: Experimental phenomenology, shape memory effect, phase transformation, Tanaka’s constitutive model, testing of SMA wires, vibration control through SMA, multiplexing. Applications of SMA and problems. ER and MR fluids: Mechanisms and properties, fluid composition and behavior, the Bingham plastic and related models, pre-yield response, post-yield flow applications in clutches, dampers and others.

Module-3

Vibration absorbers: Series and parallel damped vibrations (overview), active vibration absorbers, fiber optics, physical phenomena, characteristics, sensors, fiber optics in crack detection, applications. Control of structures: Modeling, control strategies and limitations, active structures in practice.

Module-4

MEMS: Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.

Module-5

Devices: Sensors and Actuators, conductivity of Semiconductors, crystal planes and orientation, Stress and Strain Relations, Flexural Beam Bending Analysis under simple loading conditions, polymers in MEMS, optical MEMS applications.

Course outcomes:

At the end of the course the student will be able to:

CO1. Understand the behavior and applicability of various smart materials.

CO2. Design simple models for smart structures & materials.

CO3. Devise experiments to verify the predictions.

CO4. Judge the appropriate application of smart materials with respect to the feasibility of their fabrication and implementation, and to the economic aspects.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996 (ISBN : 0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267

Reference Books

1. Electro ceramics: Materials, Properties and Applications - A. J. Moulson and J. M. Herbert. John Wiley & Sons, ISBN: 0471497429
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
3. Piezoelectric Actuators and Wtrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).
4. Handbook of Giant Magnetostrictive Materials - G. Engdahl, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
5. Shape Memory Materials - K. Otsuka and C. M. Wayman, Cambridge University Press, Cambridge; New York, 199~ (ISBN:052144487X).

Group no.	**5**	Subject Code	20MST323	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**NON-TRADITIONAL MACHINING**				

Module-1

Introduction: Need for non-traditional machining processes, Process selection, classification, comparative study of different processes. Ultra-Sonic Machining: Definition, Mechanism of metal removal, elements of the process, Tool feed mechanisms, Theories of mechanics, effect of parameters, Different types of concentrators, horn design, applications, Limitations. Abrasive Jet Machining: Principle, Process parameters, Influence of process parameters on MRR , applications, advantages and disadvantages. Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery.

Module-2

Thermal Metal Removal Processes: Electric discharge machining, Principle of operation, mechanism of metal removal, basic EDM circuitry, spark erosion generators, Analysis of relaxation type of circuit, material, removal rate in relaxation circuits, critical resistance parameters in Ro Circuit, Die electric fluids, Electrodes for spark erosion- surface finish, applications. Electro Chemical machining (ECM): Classification of ECM process, Principle of ECM, Chemistry of the ECM process, parameters of the process, Determination of the metal removal rate, dynamics of ECM process, Hydrodynamics of ECM process, polarization, Tool Design, advantages and disadvantages-applications. Electro Chemical grinding, Electro Chemical honing, Electrochemical deburring.

Module-3

Chemical Machining: Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications, chemical blanking, chemical milling (contour machining), Hydrogen embrittlement. Plasma arc Machining: Introduction, Plasma, Generation of Plasma and equipment, Mechanism of metals removal, PAM parameters, process characteristics, types of torches, applications. Electron beam machining (EBM): Introduction, Equipment for production of Electron beam, Theory of electron beam machining, Thermal & Non thermal type, Process characteristics, applications.

Module-4

Laser Beam Machining: Introduction, principles of generation of lasers, Equipment and Machining Procedure, Types of Lasers, Process characteristics, advantages and limitations, applications of laser beam machining. CO2 Laser: Principle, Equipment, Applications. Ion Beam Machining: principle, equipment, working, sputtering rate, applications.

Module-5

High Velocity forming processes: Introduction, development of specific process, selection, comparison of conventional and high velocity forming methods.Types of high velocity forming methods: explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications, Advantages and limitations.

Course outcomes:

At the end of the course the student will be able to:

1. Student will be in a position to appreciate the merits of non traditional machining and its application in Industries.
2. Justify and demonstrate the benefits of non-traditional machining processes over traditional machining processes.
3. Students will be able to decide a process suitable for a particular material based on the availability of the sources.
4. understand the applicability of the process and its benefits.
5. Ability to setup NTM in any industry.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

1. Modern Machining Process - P.C Pandey & H.S Shan Tata Mc Graw Hill.
2. Modern Machining Processes - P.K Mishra, Paperback – Import, 30 Jan 1997, Narosa publishers.
3.Thermal Metal Cutting Processes-Dr.B.J. Ranganatha, I K International, New Delhi

Reference Books

1. New technology - Bhattacharya, Institution of Engineers, India
2. Production technology - HMT Tata Mc Graw Hill.
3. Metals hand book - ASM Vol-3.
4. High velocity forming of metals - F.M Wilson ASTME PrenticeHall.
5. Modern Manufacturing Methods - Adithan

Group no.	**5**	Subject Code	20MTE251	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**PRODUCT DESIGN TECHNOLOGY**				

Module-1

Introduction: Characteristics of successful product development who Designs and develops products, duration and cost of product development, the challenges of product development.

Development Processes and Organizations: A generic development process, concept development; the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization.

Module-2

Product Planning: The product planning process, identify opportunities, Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of needs and reflect on the results and the process.

Product Specifications: What are specifications, when are specifications established, establishing target specifications setting the final specifications.

Concept Selection: Overview of methodology, concept screening, concept scoring, caveats.

Module-3

Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result and reflect on the results and the process.

Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues

Module-4

Industrial Design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.
Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact the DFM on other factors .

Module-5

Course outcomes:

At the end of the course the student will be able to:

1. Students will be able to demonstrate their knowledge in various aspects of product development.
2. Knowledge of identifying the customer needs and aspects,
3. To have idea of product specifications,
4. Knowledge of product survey and methods of surveys and
5. Awareness of ergonomics and aesthetics designs with customer needs.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Product Design and Development, Karl,. T. Ulrich, Steven D. Eppinger, Irwin McGraw Hill.
2. Product Design for Manufacture and Assembly, Geoffery Boothroyd, Peter Dewhurst and Winston Knight.

Reference Books

1. Product Design and Manufacturing, A C Chitale and R C Gupta, PH1.
2. New Product Development, Timjones Butterworth Heinmann, Oxford, UCI.1997.

Group no.	**5**	Subject Code	20MAR251	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**NETWORKING AND IOT**				

Module-1

Introduction to IoT Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models &APIs.
IoT & M2M Machine to Machine, Difference between IoT and M2M, Software define Network

Module-2

Network & Communication aspects Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.

Module-3

Challenges in IoT Design challenges, Development challenges, Security challenges, Other challenges.

Module-4

Domain specific applications of IoT Home automation, Industry applications, Surveillance applications, Other IoT applications.

Module-5

Developing IoTs Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.

Course outcomes:

At the end of the course the student will be able to:

- Interpret the design aspects and communication models of IoT.
- Examine the design, development, security and deployment challenges pertaining to IoT.
- Analyze the media access control protocols, routing protocols and node discovery strategies used in IOT.
- Explain the data dissemination and aggregation techniques used by IoT sensors.
- Examine the domain specific IoT applications.
- Apply python programming to and develop simple IoT applications

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things.by David Hanes, Cisco Press,2007

(2) Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach"

Reference Books

(1) Computer Networks; By: Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi, 4th Edition 6

(2) Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice

(3) Data and Computer Communications; By: Stallings, William; Pearson Education Pte. Ltd., Delhi, 6th Edition

Group no.	**5**	Subject Code	20CAE243	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**VEHICLE AERODYNAMICS**				

Module-1

Introduction to Road Vehicle Aerodynamics Basic principles of road vehicle aerodynamics; evolution of road vehicles; borrowed shapes; streamlining era; parametric studies; one-volume bodies; bathtub bodies; commercial vehicles; motorcycles; shape and detail optimization; futuristic trends; performance analysis of cars and light Trucks.

Module-2

In Motion dynamics vehicle equation of motion; aerodynamic drag; tire rolling resistance; climbing resistance; effective mass; traction diagram; acceleration capability and vehicle elasticity; fuel consumption and economy; gear-ratio re-matching; EPA driving cycles – urban, highway, combined; low fuel consumption strategies.

Module-3

Directional Stability, Safety and Comfort Flow field around a vehicle; interior and exterior flows; attached, separated and oscillating flows; aerodynamic forces and moments; cornering and side wind behaviors; stability index; passing maneuvers; spoiler design; safety and aesthetics; water and dirt accumulation; visibility impairment; ventilation, air flow and odor removal. Engine and interior cooling; radiators; HVAC systems.

Module-4

Race Car, High performance and Commercial Vehicle Race cars: Front wings, Rear wings, Weight distribution, Over steer and Under steer, Center of 80 gravity effects, Split streaming. Commercial vehicle aerodynamics: Truck Aerodynamics, Improvements in design, Different styles of trailers. Effect of gap between truck and trailer, fairings. Measurement and Testing Techniques Wind tunnel and on-road testing techniques; classification and design of wind tunnels; instrumentation and data acquisition; wind tunnel components and corrections; road testing methods; cross-wind and engine cooling tests; soiling, water and dirt accumulation, visibility measurements on road; wind noise models, analysis and measurement

Module-5

Computational Fluid Dynamics and Applications Introduction to CFD analysis; CFD vs. experimentation; Fundamentals of fluid mechanics; Continuity, Navier-stokes and energy equations; Modeling and Discretization techniques; basic steps in CFD computation; 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks; turbulence models; Eddy viscosity and non-eddy viscosity models; RANS and ARSM models; LES and DNS methods. Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies;

Vorticity based grid-free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation; animation of air-flow and fluid-body interaction

Course outcomes:

At the end of the course the student will be able to:

- To understand the aerodynamics of vehicles
- To apply principles of dynamics in real time vehicles.
- To apply different techniques to measure and test vehicles on-road and in test labs.
- Employ CFD to understand the flow behavior over the road vehicle model.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

Theory and Applications of Aerodynamics for Ground Vehicles- T. Yomi Obidi. Published by SAE, 2014, ISBN 978-0-7680-2111-0.

Reference Books

1 . Competition Car Aerodynamics, A Practical Hand Book, 3rd Edition, Simon McBeath, Willem Toet, Published by Veloce Publishing, 2015 ISBN 978-1845847760.
2 . Aerodynamics of Road Vehicles, W.H.Hucho, Published by SAE International, 2015.
3 . Low Speed Wind Tunnel Testing, 3rd Edition, Jewel B. Barlow, William H. Rae Jr., Alan Pope, Wiley India Pvt Ltd, 2010

Group no.	**5**	Subject Code	20MSE23	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCED PROCESSING OF MATERIALS**				

Module-1

Casting Process: Introduction, various manufacturing processes, convectional casting processes, special casting processes, squeeze casting processes, foam casting, melting processes, Types of furnace, melting using cupola furnace, Resistance furnace, Induction furnace.

Powder Metallurgy Process: Introduction, benefits of power metallurgy process, limitations and applications of process, flow chart of process, various methods of production of powder, powder treatment, powder characteristics, compaction of powder and its methods, pre-sintering, operation before sintering, sintering, operating after sintering.**10 Hrs**

Module-2

Mechanical Alloying: Introduction and process of mechanical alloying, milling parameters in mechanical alloying, material synthesizing using mechanical alloying, phase formed in mechanical alloying, mechanical alloying of miscible systems, mechanical alloying of immiscible systems, oxide dispersion strengthened alloys, reactive milling, phase transition observed in mechanical alloying.

10 Hrs

Module-3

Advance Processing and Forming: Introduction: abrasive finishing, Chemical mechanical polishing (CMP) technology, photochemical machining, high voltage forming of metal, explosive forming or fabrication, Electrochemical hydraulic forming, magnetic pulse forming.**10 Hrs**

Module-4

Processing of polymer materials and latest trends in manufacturing processes: Introduction, processing of plastic, compression moulding, injection molding, extrusionmolding, blow molding, ageing of polymer, Effect of temperature, UV and solar radiations,Introduction to agile manufacturing and green manufacturing, Advantages and application ofagile manufacturing, Advantages and application of green manufacturing.**10 Hrs**

Module-5

Metal injection moulding (MIM) and self-propagating high temperature synthesis processes: Introduction, steps in MIM, Advantages and requirements of MIM, materialsprocesses of MIM, SHS process: Introduction, Types of SHS, reaction mechanics, parametersto be considered in SHS, Types of SHS products and applications microwaves sintering ofmetals process, Types of SHS products and applications, process parameters for microwavesintering,
Advantages and limitations.**10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the concept of joining processes for various materials and methods to avoid distortion.
2. Understand various non-conventional welding process.
3. Inspect the welds using DT and NDT techniques and learn the weld symbols.
4. Design the welding and applying quality control techniques.
5. Apply computer software for weld design.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module**.**

Textbooks

(1) MANUFACTURING TECHNOLOGY by ROA P N, TATA Mc Grew Hill 1996

(2) Principles of materials science and engineering by W F SMITH, Tata Mc Grew Hill

Reference Books

(1) Manufacturing engineering and technology by Kalpakjain. S

(2) Modern machining processes by P C Pandey and shah, Tata Mc Grew Hill, NewDelhi.

INDUSTRIAL MARKETING			
Course Code	**20MEM321**		
		Exam Hours	03

Module-1

Introduction: The Industrial Marketing Concept Marketing System: Participant, Channels, Contracts of Sale, Franchise Agreements Loyalty, Confidence and Reciprocity.
Demand and Product Characteristics: Market levels and product type. Derived demand; Influence of ultimate buyer, business conditions, Financial conditions, Influenceofprice. **08HRs**

Module-2

Industrial Customer: Buyer Motives: The core variables, Quality, Service, Price, Savings assurance of supply and buyer temperament, Buyer characteristics, Customer types.
Marketing Strategy: The concept of strategy Mission Strategy, Operating, plans, Organizational Plan and logistical plans; choiceof
strategycomponents. **08HRs**

Module-3

The Channel Component: Industrial Distributors, Geographical Distributions, Size, Characteristics. Condition influencing channel structure, Intensive versus selective strategy.

The Price Component: Condition affecting price: Condition affecting price: Competition, firm size product type, Direct and Indirect Costs. The nature of demand. Pricing decisions, New Markets versus established markets pricing policies; Net pricing; Discount pricing, trades discount, Quantity discounts andcash
discounts. Legal considerations andpricing methods. **08HRs**

Module-4

The Promotional Component: Advertising functions, motivating distributions sales and message case of advertising agencies. Sales promotion and public relations promotional letters andnovelties personal selling andsellingsupport. **08HRs**

Module-5

Marketing Control: Strategic goals. Identifying market opportunity. Short-termgoals expense based goals. The market and sales budget.
Budgetary Control, the process of control. Comprising standards and performance.Correctiveaction. **08HRs**

Course outcomes:
At the end of the course the student will be able to:
1. Analyse the Industrial Marketing Concept.
2. Understand the Industrial Customer&MarketingStrategy
3. Understand the The ChannelComponent.
4. Understand the Advertising functions, motivating distributionssales and message case of advertisingagencies.
5. Understand the concept of marketing controls, strategicgoals.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbooks

(1) **Industrial Marketing -**Richard M. Hill.Ralph. S. Alexander and James S. Cross. Published by AITBS, New Delhi.

(2) **Industrial Marketing -**Phadtare, PHI Pvt., Ltd

Reference Books

(1) **Industrial Marketing -A process of creating and maintaining exchanges**- KrishnamachryulyCsg, Lalitha R - Jaico Book House

Group no.	**5**	Subject Code	**20MPE13**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ADVANCED FOUNDRY TECHNOLOGY**				

Solidification of Casting: Concept of solidification of metals. Homogenous and heterogeneous nucleation. Growth mechanism. Solidification of pure metals and alloys. Mechanism of columnar and dendritic growth. Coring or Segregation. Solidification time and Chvorinov's rule. Concept of progressive and directional solidifications.
10 Hrs

Module-2

Principles of Casting and Risering: Purpose of the gating system. Components of the gating System and its functions. Design of the gating System. Different types of gates. Gating ratio and its functions. Definition and functions of the riser. Types of risers and their application. Design of the riser - its shape. Size and location. Use of insulating material and exothermic compounds in risers.

Design of Casting: Factors to be considered in casting design. Design consideration in pattern making, moulding techniques and core making and assembly. Cooling stresses and hot spots in casting and modification in casting geometry to overcome them.

Casting Quality Control: Casting defects and factors responsible for them. Different inspection and testing methods to evaluate the casting. Quality control activities in a foundry. Salvaging methods of defective casting.
10 Hrs

Module-3

Furnace Technology: Study of various furnaces used in foundry, construction and operation of crucible and hearth furnaces. Resistance, Arc and Induction furnaces-their construction. Operation and application. Heat treatment furnaces and drying ovens used in foundry.

Gray Cast - Iron Foundry Practice: Chemical Composition and structure of gray cast iron. Moulding, gating and risering techniques. Melting of gray cast iron in Cupola and induction furnace. Inoculation of gray cast iron. Application of gray cast iron castings.

Malleable Cast Iron: Chemical composition and structure of White- heart and black-heart malleable cast iron. Melting malleabilisation heat treatment and application of malleable cast iron.

Ductile Cast Iron: Chemical composition and structure of ductile cast iron. Melting and spherodisation treatment. Inoculation of 'ductj)e iron Properties and application of ductiles iron casting.

10 Hrs

Module-4

Steel Casting Practice: Common steel casting, their composition, structure and properties. Melting and refining of steel. Gating and risering of steel castings cleaning of steel castings.

Aluminium Foundry Practice: Composition, properties and application of common aluminium alloy casting. Melting and casting of AI-alloys. Gating and risering of AI-alloy casting.

10 Hrs

Module-5

Copper alloy Foundry Practice: General characteristics of common cast copper alloys. Melting and casting of copper alloys. Gating and risering of cu-alloy castings.

10 Hrs

Course outcomes:

At the end of the course the student will be able to:

1. Understand the Solidification process, Gates and Risers types and design
2. Design simple casting design and learn casting defects
3. Understand constructional features and working of different foundry furnaces
4. Understand Ferrous and Aluminum metals and alloys
5. Understand Foundry Mechanization and Modernization

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

(1) **Principle of metal casting** - Heine, et. al - Tata-McGraw-HiII Publication - 2003.

(2) **A test book of FoundryTechnology** - Lal, M. Khanna, P.O - DhanpatRai & Sons Publication.

(3) **Foundry Technology** - Beelely, P.R. – Butterworth.

Group no.	**5**	Subject Code	20MTE331	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN FOR MANUFACTURE**				

Module-1

Effect of Materials and Manufacturing Process on Design: Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, Weighted properties and limits on properties methods.

Tolerance Analysis: Process capability, mean, variance, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance- Sure fit law and truncated normal law.

Module-2

Selective Assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups - Model-1: Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play -Introducing secondary machining operations, Laminated shims, examples.

Datum Features: Functional datum, Datum for manufacturing, Changing the datum. Examples.

Module-3

Design Considerations: Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and Machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviate sand cores.

Component Design: Component design with machining considerations link design for turning components -milling, Drilling and other related processes including finish- machining operations.

Module-4

True positional theory: Comparison between co-ordinate and convention method of feature location. Tolerance & true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging.

Module-5

Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft.

Course outcomes:

At the end of the course the student will be able to:

1. Students will be able to demonstrate their understanding of tolerance specification and considerations to be given importance in design for manufacture.
2. Knowledge of Process capability in manufacturing.
3. Understanding the concept of Interchangeability and Selective assembly.
4. Awareness of the Component design.
5. Understanding the designs of gauges in checking the hole and shaft components..

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Designing for Manufacturing - Harry Peck, Pitman Publications, 1983.
2. Machine Design - Dieter McGraw hill Publications for topic 1
3. Metrology - R.K. Jain Khanna Publication for topic 6.
4. Product design for manufacture and assembly - Geoffrey Boothroyd, peter dewhurst, Winston Knight, Merceldekker. Inc. New york.
5. Material selection and Design, Vol. 20 - ASM Hand book.

Group no.	**5**	Subject Code	20MCM243	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**METROLOGY AND COMPUTER AIDED INSPECTION**				

Module-1

Metrology and Techniques: Standards in metrology, definitions, Traceability, Characteristics Length & Angular measurements-Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology Instruments, Methods and new approaches.

Module-2

Laser Applications in Metrology: LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements.

Module-3

Special Measuring Instruments and Techniques: Optoelectronic devices, contact and non-contact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalisation, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system.

Module-4

Co-ordinate Measuring Machine: Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging in computers.

Module-5

Sensors in Inspection: Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection, Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches. Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors

Course outcomes:

At the end of the course the student will be able to:

- Acquire the basic knowledge and practice regarding Quality Assurance through different Computer Aided Inspection and Newest Metrology Precision Instruments.
- Basic information and real time applications of LASER technology in the field.
- Get knowledge of modern measuring technics their application for Digitizing the Production Time.
- Get knowledge applications and principal of CMM mechanics
- Apply various sensors for process control and product quality monitoring

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) Fundamentals of dimensional Metrology T. Busch and R. Harlow Delmar, 3e

(2) Engineering Metrology G. Thomas and G. Butter Worth PUB

(3) Sensors and Control systems in Manufacturing Sabne Soloman McGraw Hill Book

(4) Measurement systems: Applications & Design Doebelin International Student Edition

Reference Books

(1) Optoelectronics for Technology and Engineering Robert G. Seippel Prentice Hall India

(2) Interface Technology for Computer Controlled Manufacturing processes Ulrich-Rembold, Armbruster and Ulzmann Marcel Dekker Publications, NY 7

(3) Optoelectronics J. Watson Van Nostrand Rein Hold (UK) Company

(4) ASME, Hand book of Industrial Metrology,1998

6	20MTP242	Thermal power station
6	**20MTP253**	**Computational methods in Heat transfer and fluid Flow**
6	20MTP322	Theory of I.C Engine
6	20MMD324	Experimental Mechanics
6	**20MMD333**	**Design of hydraulic and pneumatic system**
6	20MST31	Plastic procession
6	20MTE242	Tooling for Manufacturing in Automation
6	20MAR31	Artificial Intelligence and expert system in Automation
6	**20CAE253**	**Design of Micro Electro Mechanical system**
6	**20MSE253**	**Surface treatment and Finishing**
6	**20MEM323**	**Industrial design and Ergonomics**
6	20MPD254	Design of Experiment
6	20MTP334	Thermal storage system
6	20CAE321	Mechatronics System Design

Group no.	**6**	Subject Code	20MTP242	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**THERMAL POWER STATION**				

Module-1

Steam Generator and Auxiliaries: High pressure boilers, classification, schemes¸ circulation, nature of fuels and its influence on design, furnaces, PF burners, PF milling plant, oil and gas burner types and location, arrangement of oil handling plant. Waste heat recovery systems. Operation and Maintenance of Steam Generators and auxiliaries: Pre commissioning activities, Boiler start up and shut down procedures, emergencies in boiler operation, Maintenance of Steam generator and auxiliaries.

Module-2

Dust Extraction Equipment: Bag house, electrostatic precipitator, draught systems, FD, ID and PA fans, chimneys, flue and ducts, dampers, thermal insulation and line tracing, FBC boilers and types., waste heat recovery boilers.

Module-3

Feed Water system: Impurities in water and its effects, feed and boiler water corrosion, quality of feed water, boiler drum water treatment and steam purity, water treatment, clarification, demineralization, evaporation and reverse osmosis plant. Circulating water system: Introduction, System classification, The circulation system, Wet-Cooling towers, Wet-cooling tower calculations, Dry cooling towers, Dry-cooling towers and plant efficiency and economics, wet-dry cooling towers, cooling-tower icing, Cooling lakes and ponds, Spray ponds and canals.

Module-4

Performance: Boiler efficiency and optimization, coal mill, fans, ESP. EIA study: Pollutants emitted, particulate matter, SOx and NOx and ground level concentration, basic study of stack sizing.

Module-5

Miscellaneous of steam power plant: Methods of loading, plant selection, arrangements, useful life of plant components, pumps, cost estimation steam power plant, comparison of different power plants, current scenario of thermal power generation in India, Indian boiler act and amendments, case studies.

Course outcomes:

At the end of the course the student will be able to:

- **CO1:** Describe the working principle, operation and maintenance of a various steam generators.
- **CO2:** Identify the arrangements of different flow systems their operation and maintenance.
- **CO3**: Illustrate the impact of thermal power plant exhaust on environment.
- **CO3:** Estimate the working expenses, current scenario and trends in power generation.
- **CO4:** Asses the performance and suitability of thermal power plant.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

1. **Power Plant Engineering -** P.K. Nag, Tata McGraw-Hill Publications. 2nd edition
2. **Power Plant Engineering -** M.M. EI-Wakil, McGraw- Hill Publications. 1st edition
3. **Power plant engineering –**R.K.Rajput ,Laxmi Publications 3rd edition

Group no.	**6**	Subject Code	20MTP253	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**COMPUTATIONAL METHODS IN HEAT TRANSFER & FLUID FLOW**				

Module-1

Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods. Governing equations of fluid dynamics: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching.

Module-2

Mathematical behavior of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations. **Basic aspects of discretization**: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points. **Grids with appropriate transformation**: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.

Module-3

Parabolic partial differential equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization**. Stability analysis**: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, artificial dissipation and dispersion.

Module-4

Elliptic equations: Finite difference formulation, solution algorithms: Jacobi -iteration method, a Gauss- Siedel iteration method, point- and line-successive over-relaxation methods, and alternative direction implicit methods. **Hyperbolic equations**: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order tvd schemes.

Module-5

Scalar representation of Navier-stokes equations: Equations of fluid motion, numerical algorithms: FTCS explicit, FTBCS explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, BTCS and BTBCs implicit algorithms, applications. **Grid generation:** Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation. **Finite volume method for unstructured grids:** Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetrahedral Elements, 2-D Heat conduction with Triangular Elements Numerical solution of quasi one-dimensional nozzle flow: Subsonic-Supersonic isentropic flow, Governing equations for Quasi 1-D flow, Non-dimensionalizing the equations, MacCormack technique of discretization, Stability condition, Boundary conditions, Solution for shock flows

Course outcomes:

At the end of the course the student will be able to:

- **CO1:** To derive the stepwise procedure to completely solve a fluid dynamics problem using computational methods.
- **CO2:** To explain the governing equations and understand the behaviour of the equations.
- **CO3:** To determine the consistency, stability and convergence of various discretization schemes for parabolic, elliptic and hyperbolic partial differential equations.
- **CO4:** To verify variations of SIMPLE schemes for incompressible flows and Variations of Flux Splitting algorithms for compressible flows.
- **CO5:** To identify various methods of grid generation techniques and application of finite difference and finite volume methods to various thermal problems.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Numerical Heat Transfer and Fluid Flow - S.V. Patankar, Hemisphere Publishing Company.
2. Computational Fluid Dynamics - T.J. Chung, Cambridge University Press 2003
3. Computational fluid flow and heat transfer - K. Murlidhar and T. Sounderrajan, Narosa Publishing Co.
4. Computational fluid mechanics and heat transfer - D. A. Anderson, J. C. Tannehill, R.H. Pletcher, Tata McGraw-Hill Publications 2002
5. Computational fluid dynamics - J.A. Anderson, McGraw-Hill Publications 1995
6. An Introduction to Computational Fluid DynamicsVersteeg, H.K. and Malalasekara, W, Pearson Education, 2010

Group no.	**6**	Subject Code	20MTP322	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**THEORY OF IC ENGINES**				

Module-1

Introduction to IC Engines: Basic engine components and nomenclature ,Applications of IC Engines **,** Engine characteristics, geometrical properties of reciprocating engines, specific emissions and emission index, relationships between performance parameters, Engine design and performance data. Energy flow through IC engines, Various Auxiliary systems. Environment friendly engines. Fuel –Air and Actual Engines: Modeling of Fuel-Air cycle Effect of operating variables on the performance of Fuel –air Cycles, Detailed analysis of difference between Fuel-Air and Real Cycle, Combustion charts and Gas Tables.

Module-2

Carburetion: Introduction, Factors affecting carburetion, mixture requirements at different load and speed, principles of carburetion, essential parts and functions of a carburetor, compensating devices, Modern Carburetors, Altitude compensation devices, Injection in SI engine. **Injection Systems:** Introduction to Mechanical Injection System, Functional Requirements and classification, Fuel feed pump and Fuel Injector, **Electronic injection systems:** Types, Merits and Demerits, Multi point fuel injection system (MPFI), Electronic control system , Injection timings, Common –Rail Fuel Injection System.

Module-3

Modeling of IC Engines : Governing Equation for open thermodynamic systems, intake and exhaust flow models, Thermodynamic based in cylinder models, Direct-injection CI engine models, Combustion models, Fluid Mechanics based multi-dimensional models.

Module-4

Engine emissions and their control: Air pollution due to IC engines, emission characteristics, Euro norms, engine emissions, Hydro carbon emissions, CO emission, NOx- Photo chemical smog, Particulates, other emissions, Smoke, emission control methods – thermal converters, catalytic converters, particulate traps, Ammonia injection systems, exhaust gas recirculation, ELCD, Crank case blow by control. IC engine Noise characteristics, types, standards and control methods, Air quality emission standards **Measurement:** Noise, Emission, Pressure, crank angle torque, valve timings, temperature and flow measurements.

Module-5

Alternate fuels for IC engines: Vegetable oils, alcohol, LPG, CNG, Hydrogen fuels, Bio gas, Dual fuels, other possible fuels Case studies: The rover K series engine, Chrysler 2.3 liter SI engine, Ford 2, 5 Liter DI Diesel Engine.

Course outcomes:

At the end of the course the student will be able to:

- **CO1:** Distinguish different Fuel-air and actual cycles.
- **CO2:** Demonstrate the different types of injection and carburetor systems
- **CO3:** Formulate the flow and combustion phenomenon for modeling
- **CO4:** Identify the various types of emissions, noise and their control systems
- **CO5:** Recommend the suitable alternative fuel for IC Engine.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill Publications, 4th Edition.
2. John B Heywood, "IC Engines fundamentals", McGraw- Hill Publications,2011.
3. C R Fergusan, "Internal Combustion Engines: Applie d Thermo sciences", John Wiley & Sons.
4. Richard stone ''Introduction to IC Engines'' Palgrave Publication 3rd edition.
5. Charles Fayette Taylor '' The Internal-Combustion Engine in Theory and Practice'' MIT Press 2nd edition.

Group no.	**6**	Subject Code	20MMD324	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**EXPERIMENTAL MECHANICS**				

Module-1

Introduction:Definitionofterms,calibration, standards, dimension and units,generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

Analysisof ExperimentalData: Causeand types of experimentalerrors,erroranalysis.Statisticalanalysisof experimentaldata-probabilitydistribution, Gaussian, Normaldistribution. Chi-square test, methodof least square, correlation coefficient, multivariable regression, standard deviation of mean,graphicalanalysisandcurvefitting,generalconsiderationindataanalysis.

Module-2

Data Acquisition and Processing: General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion. Basic components (storageanddisplay) of data acquisition system. Computerprogramasasubstitute forwiredlogic.

Force,TorqueandStrainMeasurement: Massbalancemeasurement,elasticelementfor forcemeasurement,torquemeasurement.Strain gages-strainsensitivityofgagemetals,gageconstruction,gagesensitivityandgagefactor,performancecharacteristics,environmentaleffects, Straingagecircuits,Potentiometer, WheatStone'sbridges,Constantcurrentcircuits.Strainanalysismethods-two elementand threeelement,rectangularanddeltarosettes,correctionfortransversestrainseffects,stressgage- planesheargage,stressintensityfactor gage.

Module-3
StressAnalysis: TwoDimensionalPhotoelasticity-natureoflight,-wavetheoryoflight,-opticalinterference-Polariscopesstressopticlaw effect ofstressed modelinplaneandcircularpolariscopes, Isoclinics, Isochromaticsfringeorder determination -Fringe multiplicationtechniques-Calibrationphotoelasticmodelmaterials.Separationmethodssheardifferencemethod,Analyticalseparationmethods,Model toprototypescaling
Module-4
ThreeDimensionalPhotoelasticity: Stressfreezingmethod,Generalslice,Effectivestresses,Stressesseparation,Shear deferencemethod, Obliqueincidencemethod,secondaryprincipalsstresses,scatteredlightphotoelasticity,Polariscopeandstressdataanalyses**.**
Module-5
CoatingMethods: a)PhotoelasticCoating Method-Birefringence coating techniques,SensitivityReinforcing and thickness effects -data reduction-Stressseparation techniques,Photoelasticstraingauges. b)BrittleCoatingsMethod:BrittlecoatingtechniquePrinciplesdata analysis-coatingmaterials,Coatingtechniques. c)MoireTechnique-Geometricalapproach,Displacementapproach-sensitivityofMoiredatareduction,InplaneandoutplaneMoiremethods,Moirephotography,Moiregridproduction. **Holography:** Introduction, Equationforplane waves andspherical waves, Intensity, Coherence, Spherical radiator asanobject (record process),Hurter,Driffeldcurves,Reconstructionprocess,Holograpicinterferomerty, Realtimeanddoubleexposuremethods,Displacement measurement,Isopachics.
Course outcomes: At the end of the course the student will be able to:

C01	Mount strain gages, take measurements and analyze the obtained data.
C02	Design strain gage-based transducers for measuring specific loads.
C03	Describe the different methods photo elasticity for strain measurement viz, stress freezing , and Moirés method.
C04	Undertakeexperimentalinvestigationstoverifypredictionsbyothermethods.
C05	Apply the principles and techniques of brittle coating analysis.
C06	Apply the principles and techniques of holographic interferometry.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1Holman,"ExperimentalMethodsforEngineers"7th Edition,TataMcGraw-HillCompanies,Inc,NewYork,2007.

1. R.S.Sirohi,H.C.RadhaKrishna,"Mechanicalmeasurements"NewAgeInternationalPvt.Ltd.,NewDelhi,2004
2. ExperimentalStressAnalysis-Srinath,Lingaiah,Raghavan,Gargesa,RamachandraandPant,TataMcGrawHill,1984.
3. Instrumentation,MeasurementAndAnalysis-Nakra&Chaudhry,BCNakraKKChaudhry,TataMcGraw-HillCompanies,Inc,NewYork, SeventhEdition,2006.

Reference Books

1. MeasurementSystemsApplicationandDesign-DoeblinE.A.,4th(S.I.)Edition,McGrawHill,NewYork.1989
2. DesignandAnalysisofExperiments- MontgomeryD.C.,JohnWiley&Sons,1997.
3. ExperimentalStressAnalysis-DallyandRiley,McGrawHill,1991.
4. ExperimentalStressAnalysis-SadhuSingh,Khannapublisher,1990.
5. PhotoelasticityVolIandVolII-M.M.Frocht,.JohnWileyandsons,1969.
6. StrainGaugePrimer-PerryandLissner,McGrawHill,1962.

Group no.	6	Subject Code	20MMD333	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN OF HYDRAULIC & PNEUMATIC SYSTEMS**				

Module-1

Introduction to Hydraulic System: Introduction, Basic hydraulic system, classification of hydraulic motors, hydraulic pumps, Performance of hydraulic motors, Hydraulic actuators, types of hydraulic actuators. Control Components in Hydraulic Systems: Introduction, Direction control valves, Solenoid actuated valve, Pilot operated valve, Rotary spool DCV, Pressure control valves, Hydraulic fuse, Flow control valve, graphic symbols.

Module-2

Maintenance of Hydraulic Systems: Prime function of hydraulic fluids, desirable properties of hydraulic fluids, general types of fluids, factors affecting the selection of fluids, sealing devices, reservoir systems, filters and strainers, heat exchangers, pressure switch, wear of moving parts, troubleshooting of hydraulic systems.

Module-3

Hydraulic circuit Design and Analysis: Control of a single acting cylinder, double acting cylinder, regenerative circuit, counter balance valve applications, Hydraulic cylinder sequencing circuits, automatic cylinder reciprocating systems, Locked cylinder using pilot check valves, cylinder synchronizing circuits, fail safe circuits.

Module-4

Pneumatic Concepts: Introduction, comparison of hydraulics/pneumatics/and electrical system, air compressor system, types of compressors, compressed air behavior, pneumatic actuators, direction control valves, building a pneumatic circuits, application of logic valves. Design of Pneumatic Circuits: Speed control circuits, Application of time delay valves. Position sensing in pneumatic cylinders, roller lever valve, pressure sensing in pneumatic circuits, pressure sequence valve, two cylinder movement, cascade method.

Module-5

Electro-Pneumatics: Introduction, Pilot operated solenoid valve, Electrical connection to the solenoid, Electro-pneumatic circuit, Electrical limit switches and proximity switches, Relays, Solenoid, PE converter, Concept of latching. Servo System and PLC Applications in Pneumatics: Closed loop control with servo system, Hydro-mechanical servo system, Electro-hydraulic servo system, Conventional valve vs proportional valve, Proportional valve in hydraulic circuits, characteristics of proportional valve and servo valve. PLC application in fluid power, logic in ladder logic diagram and Mnemonics, Timer- on delay and off delay

Course outcomes:

At the end of the course the student will be able to:

CO1 Describe the constructional features of hydraulic and pneumatic components
CO2 Apply hydraulic and pneumatic controls in the design of automated controls
CO3 Evaluate the design of hydraulic and pneumatic compTWOnts for building a circuit
CO4 Design the hydraulic and pneumatic based systems for industrial applications

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks/ Reference Books

1. S Ilango, V Soundararajan, Introduction to Hydraulics and Pneumatics, PHI Publication, ISBN- 978-81-203-3079-5.
2. Jagadeesha T, Hydraulics and Pneumatics, I K International Publication, ISBN: 978-93-84588- 90-8
3. James L Johnson, Introduction to fluid power, Cengage Learning, first edition 2003, ISBN- 981- 243-661-8
4. R Srinivasan, Hydraulic and pneumatic controls, Tata McGraw hill, second edition, 2010 ISBN – 978-81-8209-138-2.

Group no.	6	Subject Code	20MST31	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**PLASTIC PROCESSING**				

Module-1

Plastic Processing: Basic principle of processing, shape and size, processing parameters, their effect and behavior, Rheology of ideal fluids, and real polymers, Effects of melt behavior on processing and product performance. Injection Moulding: Principles, process variables, moulding cycle, machinery used, parts and function, specification, construction and maintenance of injection moulding machine, start up and shut down procedure, cylinder, nozzles, interaction of moulding variables, press capacity, projected area, shot weight, concepts and their relationship to processing, trouble shooting in injection moulding, microprocessors controlled injection moulding machines.

Module-2

Extrusion: Basic principles of extruders, and extrusion process, different types of extrudes i.e. barrel, screw, drive mechanics, head, constructional features of dies, sizing and haul-off equipment for extruders of mono filaments and tubes, blown film lines, wire and cable covering system, pipe profile extrusion, co-extrusion, process variables in extrusion like heating, temperature control, dies well, and melt fracture, spacing and orientation, treating, printing and sealing, quality of extruder products, fault, causes and remedy. Compression and Transfer Moulding: Techniques, various types of compression moulds, machinery used, and common moulding faults and remedies. Transfer moulding, its advantage over compression moulding, equipment used, press capacity, integral mold, and auxiliary mould, moulding cycle, ram pressure, clamping pressure, faults and remedies.

Module-3

Blow Moulding: Blow moulding process, processing parameter, materials used, hand operated and automatic blow moulding machine, extrusion blow moulding, moulding cycle, faults and remedies. Thermo Forming: Basic principles, types of thermoforming, thermoforming moulds, processing parameters, faults and remedies. Rotational Moulding: Basic principle, charge size, wall thickness, temperature control, fault causes and remedies.

Module-4

Calendaring: Basic principle, process variable, end product properties and applications, secondary processing techniques like powder coating, casting, machining, and joining of plastics, metalizing, printing.

Module-5

Processing of Engineering Plastics: precautions, and start up procedure, preheating, shutdown procedure, quality control, and waste management. Ram Extrusion of PTFE, Processing of reinforced plastics, like filament winding, Hand-lay-up, spray moulding, SMC, DMC, Centrifugal casting, pultrusion, resin transfer moulding.

Course outcomes:

At the end of the course the student will be able to:

- Students will demonstrate their understanding of plastic processing, injection moulding, extrusion and thermo forming.
- Application of various processes for practical purposes.
- Knowledge of different plastic materials.
- Design & Execution of plastic processing equipments.
- Metallurgical behavior of materials.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

Handbook of Plastic Processes Editor(s): Charles A. Harper First published:7 October 2005 Print ISBN:9780471662556 |Online ISBN:9780471786580 |DOI:10.1002/0471786586 Copyright © 2006 John Wiley & Sons, Inc.

Plastics processing technology Front Cover Edward A. Muccio ASM International, 1994 - Technology & Engineering - 320 pages

Plastic Processing Data Hand Book – Dominic V Rosat o P.E.

Modern Plastics Hand Book – Charles A Harper.

Reference Books

1. Injection Mould Design, Pye R.G. W. - New York-John Wiley & Sons 12th Ed.1989.
2. Injection Moulding Theory & Practice, Rubin. J. Irvin, New York John Wiley & Sons.
3. Blow Moulding Hand Book, Rosato, New York-Oxford University-Hanser Publishers.
4. Principles of Rotational Moulding Process, Bruins.

Group no.	**6**	Subject Code	20MTE242	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**TOOLING FOR MANUFACTURING IN AUTOMATION**				

Module-1

Mechanics of metal cutting: Introduction, measurement of cutting forces and chip thickness, force components, chip formation and primary plastic deformation, shear plane and slip line theories for continuous chip formation.

Modern Cutting tool materials: Material properties, HSS related materials, sintered tungsten carbide, cermets, ceramics, polycrystalline tools, tool coatings, coating methods, conventional coating materials, diamonds and CBN

Cutting tools: Basic types of cutting tools, turning tools, indexable inserts, groove geometry, edge preparation, wiper geometry, insert clamping methods, tool angles, threading tools, grooving and cut off tools, milling tools, types of milling cutters, milling inserts and edge clamping methods. Selection and application of Single point cutting tool and multipoint cutting tools.

Module-2

Optimization: Machining cost and production rate verses cutting speed, role of computerized optimization system, economic considerations, optimization of machining system, machining conditions, constraints, depth of cut feed and speed.

Tooling Requirements for CNC Machines: Tool holding systems modular and quick change tool holding system, tool holder spindle connection, cutting tool clamping systems, milling cutter driver, side lock type chuck, collet chucks, hydraulic chucks, milling chucks. Tool magazines, Automatic Tool Changers, robotized tool assembly, tool management system. Tool monitoring, presetting and offsets, wear and radius compensation.

Module-3

Location and Clamping Methods: Basic principles of locating, locating methods & devices, Basic principles of clamping, clamping methods.

Fixtures: Definitions, General considerations, Machine considerations, Process considerations, Product considerations, Types of fixtures, Milling fixtures, Boring fixtures, Broaching fixtures, Lathe fixtures, Grinding fixtures, Steps involved in designing a fixture.

Module-4

Fixtures for Automation: Work holders for CNC, Fixturing in FMS: Part holding on Pallets, standard fixtures, pallet changers, pallet pool, flexible fixturing – principles and methodologies, modular fixturing system: T-slot based, dowel pin based, fixturing components, computer aided fixture design – locating and clamping, use of Gd & T in fixture design, fixture database.

Module-5

Plastics for Tooling materials: Introduction, Commonly used plastics for tooling, Epoxy plastics tools, Construction methods, Urethane dies Force calculation for Urethane pressure pads.

Course outcomes:

1. Students are able to decide a type of tool appropriate for machining a material,
2. Student decide on nomenclature parameters and tool optimize,
3. Understand the tooling for CNC machine,
4. To know the general knowledge of location and design a clamping method and
5. Knowledge about the plastic tools.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Tool Design, Cyrol Donaldson, Tata McGraw Hill, India.

2. Fundamentals of Tool Design, Edward G Hoffman, SME, USA.

3. Jigs & Fixtures, Joshi P.H, 2nd Edition, Tata McGraw-Hill Publishing Co. Limited, New Delhi, 2004.

4. Jigs and Fixture Hiram E Grant, Tata McGraw-Hill, New Delhi,

Reference Books.

1. Handbook of Jigs & Fixtures Design, William E Boyes,SME, USA..

2. Tool Engineering & Design, G.R. Nagpal, Khanna publications

3. Metal cutting theory and practice, David A. Stephenson, John S. Agapiou, 2nd Ed. CRC Taylor and Francis publishers.

4. Metal cutting and tool design, Dr. B.J. Ranganath, Vikas publishing house.

5. ASTME; Die Design Hand book; McGraw Hill.

6. Metal cutting applications engineering course material – by Kennametal

Group no.	**6**	Subject Code	20MAR31	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEM IN AUTOMATION**				

Module-1

Introduction: artificial intelligence in cad, applications of artificial intelligence in design. Scope and history of AI. Structure of an expert system, building an expert system. Strategies for knowledge acquisition, components of knowledge. Knowledge representation, production systems, decision tables, frame systems.

Module-2

Knowledge Representations: knowledge representations process, purposes, contexts and agents, knowledge soup, knowledge acquisition and sharing. Knowledge representation languages, issues in knowledge representation. A network representation language. LISP: Introduction to LISP. Search strategies in LISP, a recursive unification function. Interpreters and embedded languages. Logic programming in LISP. An expert system shell in LISP.

Module-3

Decision Support Systems: introduction. Basis of decision making. Typical progressive models. Intelligent models, life-cycle values. Total life-cycle cost. Compatibility analysis. Sensitivity analysis. Life-cycle ranking or rating scheme.

Module-4

Learning Processes and AI Algorithms: the general problem solver and difference tables. Resolution theorem proving. Machine learning, perceptron learning, back propagation learning, and competitive learning. The genetic algorithm: the genetic programming. Artificial life and society based learning. Methods of inference, inexact reasoning.

Module-5

Knowledge Based Design Aids: inference process, backward chaining, forward chaining, hybrid chaining. Expert system shells, feature based modeling, feature recognition, design by features, and application of feature based models.

Design of expert systems and applications: benefits and examples of expert systems. Design of expert systems, introduction to clips, pattern matching, modular design and execution control fuzzy logic, typical expert system MYCIN, DENDRAL, PROSPECTOR.

Course outcomes:

At the end of the course the student will be able to:

- Understand problem solving methods, state space problems and search methods.
- Understand knowledge acquisition and representation methods.
- Apply knowledge on decision making.
- Assess critically the techniques presented and apply them to real world problems.
- Develop knowledge of decision making and learning methods.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

(1) A guide to Expert Systems – Donald A Waterman, Addison Wesley, 1st edition, 2002.

(2) Principles of Artificial Intelligence – Springer-Verlag, Berlin, 1982.

(3) Introduction to Artificial Intelligence and Expert Systems – DAN.W.Patterson, PHI, 2nd edition, 2009.

Reference Books

(1) Understanding Decision Support System and Expert Systems-McGraw Hill, 2nd edition, 1993.

(2) Artificial Intelligence – Elain Rich, McGraw Hill, 3rd edition, 2010.

(3) Artificial Intelligence- George.F.Luger, Pearson Education, Asia, 3rd Edition,2009.

Group no.	**6**	Subject Code	20CAE253	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**DESIGN OF MICRO ELECTRO MECHANICAL SYSTEMS**				

Module-1

Introduction: Micro Electro-Mechanical Systems, Ultra Precision Engineering, Micro-sensors;Micro-actuators; Microelectronics Fabrication; Micromachining; Mechanical MEMS; ThermalMEMS, MOEMS, Magnetic MEMS, RF MEMS, Micro-fluidic Systems, Bio and Chemo Devices.

Module-2

Microfabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding.

Mechanical Sensors and Actuators: Principles of Sensing and Actuation; Beam and Cantilever; Microplates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements, Strain Measurement, Pressure measurement

Module-3

Thermal and Fluidic Micro Sensors and Actuators : Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, Micro actuator examples, Micro Fluidic systems, Fluid actuation methods, micro valves, micro pumps, micromotors-Microactuator systems.

Module-4

Surface Micromachining: One or two sacrificial layer processes, Surface micro machining requirements, Polysilicon surface micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials.

Module-5

MEMS: Characterization: Technologies for MEMS characterization, Scanning Probe Microscopy (SPM): Atomic Force Microscopy (AFM), Scanning tunneling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope.

Course outcomes:
At the end of the course the student will be able to:
CO1. Students will be in a position to demonstrate their knowledge in micro machining and micro electromechanical systems.
CO2. Students will come to know about application of memes in manufacturing sector.
CO3. Will acquire the knowledge about working of different memes devices.
CO4. Students will come to know characteristics of different memes devices and its application
CO5. Develop new ideas and applications for MEMS devices.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1. Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning PrivateLimited, 2009.
2. Stephen D. Senturia, "Microsystem Design" Springer, 2001.
3. MarcMadou, "Fundamentals of Microfabrication" Taylor& Francis Group, 2002.
4. Gregory Kovacs, "Micromachined Transducers Source book" McGraw Hill 1998.

ReferenceBooks

1. M.H. Bao, "Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes" Handbook, Elsevier.
2. NadimMaluf, An Introduction to Microelectromechanical Systems Engineering, Artech House Publishers, 2000.
3. Stephen D. Senturia, "Microsystems Design" Kluwer Academic Publishers, New York.

Group no.	**6**	Subject Code	20MSE253	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**SURFACE TREATMENT & FINISHING**				

Module-1
Fundamentals of Electro plating, galvanizing, Hot dip metal coating, thin coating, thin coating, chromium plating, Nickel plating.**10 Hrs**
Module-2
Vacuum coating, FVD & CVD metal spraying – Methods, surface preparation, mechanical properties of sprayed metals, plasma coating. **10 Hrs**
Module-3
Plastic coating of metal - PVC coating, Spherodising process details, phosphate coating - mechanism of formation, Testing of surface coating-methods.**10 Hrs**
Module-4
Heat treatment methods, Annealing, Normalizing, Tempering, Case hardening methods, flame hardening sub zero treatment, Heat treatment methods for gears, spindles, cutting tools.**10 Hrs**
Module-5
Advanced coating technologies: Hard facing, electro deposition technique, nano-coatings, coating characterization. **10 Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. To understand the principles of operations, tests to evaluate mechanical and tribological properties.
2. To understand the principles of failure analysis and examination of failed components.
3. To understand the strain rate testing, test machine requirements and specimens measurements.
4. To understand and describe the different types of coating and working principles.
5. To learn and understand different heat treatment processes and their effect on finishing.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

1. Surface preparations & finishes for Metals - James A Murphy - McGraw Hill.
2. Principles of metal surface treatment and protection - Pergamon Press Gabe, David Russell - Description, Oxford ; New York - 2d ed., 1978.

Group no.	**6**	Subject Code	**20MEM323**	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**INDUSTRIAL DESIGN & ERGONOMICS**				

Module-1

Introduction: An approach to industrial design - elements of design structure for industrial design in engineering application in modem manufacturing systems. Ergonomics and Industrial Design: Introduction - general approach to the man-machine relationship- workstationdesign-workingposition. **08HRs**

Module-2

Control and Displays: shapes and sizes of various controls and displays-multiple displays and control situations - design of major controls in automobiles, machine tools etc., - design of furniture - designof instruments. **08HRs**

Module-3

Ergonomics and Production: Ergonomics and product design ergonomics in automated systems- expert systems for ergonomic design, Anthropomorphic data and its applications in ergonomic design limitationsofanthropomorphicdata-useofcomputerizeddatabase**...**
. **08HRs**

Module-4

Visual Effects of Line and Form: The mechanics of seeing psychology of seeing, general influences of lined and form. Colour: colour and light - colour and objects - colour and the eye colour consistency - colour terms - reactions to colour and colourcontinuation
- colour onengineeringequipments. **08HRs**

Module-5

Aesthetic Concepts: Concept of unity - concept of order with variety - concept of purpose style and environment - Aesthetic expressions. Style-components of style - house style, observations style in capital goods.
Industrial Design in Practice: General design - specifying design equipments - rating the importance of industrial design – industrial design in thedesignprocess. **08HRs**

Course outcomes:
At the end of the course the student will be able to:
1. Understanding the concepts of Industrial design and man-machine relationship.
2. Design of optimistic display and control devices for various applications.
3. Applying the anthropomorphic data in ergonomicdesign.
4. Understanding the visual effects of lines, form and color on engineeringequipments.
5. Choosing appropriate aesthetic aspects for design of industrial machinery anddevices.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from each module.■

Textbooks

(1)Industrial design for Engineers - Mayall W.H. - LondonCliffee Books Ltd.

(2)Applied Ergonomics Hand Book - Brien Shakel (Edited) - Butterworth Scientific,

Group no.	6	Subject Code	20MPD254	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	DESIGN OF EXPERIMENTS				

Module-1

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.

Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal &Weibull distributions. Hypothesis testing, Probability plots, choice ofsample size. Illustration through Numerical examples. .

. **12Hrs**

Module-2

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

. **08Hrs**

Module-3

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments, Illustration through Numerical examples**. 12Hrs**

Module-4

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples. **08Hrs**

Module-5

Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger- the-better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples.

Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numericalexamples. **10Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Critically review basic concepts and models of experimental design.
2. Analyse the results of a designed experiment in order to conduct the appropriate statistical analysis of thedata.
3. Interpret statistical results from an experiment and report them in non-technicallanguage
4. Understand the different types of orthogonalarrays.
5. Analyse the Taguchi's inner and outer arrays, parameter design strategy.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20marks.
- There will be two full questions (with a maximum of four sub questions) from eachmodule.
- Each full question will have sub question covering all the topics under amodule.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

(1) Design and Analysis of Experiments, Douglas C Montgomerry, Wiley, 8th Edition
(2) Design and Analysis of Experiments, R. Panneerselvam, PHI
Reference Books
(1) Design of Experiments with Minitab, Paul Mathews, New Age International.
(2) Design of Experiments with Minitab, Virgil L Anderson and Robert A Mclean, Taylor and Francis

Group no.	**6**	Subject Code	20MTP334	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**THERMAL STORAGE SYSTEM**				

Module-1

Introduction: Need of Energy Storage, Different modes of Energy Storage, Necessity of thermal storage, Thermal Storage Devices, Areas of Applications of thermal Storage, Heat Transfer Enhancement Methods.

Module-2

Sensible Heat Storage system: Basic concept, Modeling of storage System, Water and rock bed storage- use of TRANSYS, Pressurized water storage in power plant, Packed bed storage, Stratified storage systems, Thermal storage in buildings, Earth storage, Energy storage in aquifers, Heat storage in SHS systems, Aquifers storage. Chemical Energy Storage, Thermo-Chemical, Bio-Chemical, Electro-Chemical, Fossil fuels and synthetic fuels and Hydrogen storage. **08 Hours**

Module-3

Regenerator: Parallel Flow, Counter Flow, Finite conductivity model, Non-linear Model, Transient Performance, Step Change in inlet gas temperature, Step Change in inlet gas Flow rate, Parameterization of Transient Response, Heat Storage exchangers

Module-4

Latent Heat Storage: Storage material modeling of phase change problem, Enthalpy Modeling, Heat Transfer Enhancement Configuration, Parameterization of Rectangular, Cylindrical Geometric Problems, Phase Change Materials(PCMs), Selection Criteria Of PCMs, Stefan Problem, Solar Thermal LHTES Systems, Energy Conservation Through LHTES Systems, LHTES Systems in Refrigeration and Air Conditioning Systems.

Module-5

Applications of Thermal Storage System: Food storage, Waste heat recovery, Solar energy storage, Green house heating, Drying and heating applications, Power Plant Applications, Drying and Heating for Process Industries

Course outcomes:

At the end of the course the student will be able to:

- CO1: Understand the importance of thermal energy storage systems.
- CO2: Study various types of thermal energy storage systems.
- CO3: Study the applications of thermal energy storage systems in various fields.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook/ Textbooks

1.F. W. Schmidt and A.J. Willimot, Thermal Storage and Regeneration, Hemisphere Publishing Corporation, 1981.

2.V J Liunardini, Heat Transfer in Cold Climate, D Van Nostrand Reinhold, NY, 1981.

3.Ibrahim Dincer and Marc A. Rosen, Thermal Energy Storage System and Applications,

Group no.	**6**	Subject Code	20CAE321	Exam Duration	03 Hours
				Exam Marks	100
Subject Title	**MECHATRONICS SYSTEM DESIGN**				

Module-1
Introduction: Definition and introduction to Mechatronic Systems. Modelling & Simulation of physical systems. Overview of Mechatronic products and their functioning. Measurement systems, control systems, simple controllers. Study of sensors and transducers, Pneumatic and Hydraulic Systems, Mechanical actuation systems, Electrical actuation systems, Real time interfacing and hardware components for Mechatronics.
Module-2
Electrical Actuation Systems: Electrical systems, mechanical switches, solid state switches, solenoids, DC & AC motors, Stepper motors. System Models: Mathematical models, mechanical system building blocks, electrical system building blocks, thermal system building blocks, electro-mechanical systems, hydro-mechanical systems, pneumatic systems.
Module-3
Signal Conditioning: Signal conditioning, the operational amplifier, protection, filtering, Wheatstone bridge, Digital signals, Multiplexers, Data Acquisition, Introduction to digital system processing, Pulse-modulation. MEMS and Micro systems: Introduction, working principle, materials for MEMS and Micro systems, Micro system fabrication process, overview of Micro Manufacturing, Micro system Design, and Micro system packaging.
Module-4
Data Presentation Systems: Basic System Models, System Models, and Dynamic Responses of System
Module-5
Advanced Applications in Mechatronics: Fault Finding, Design arrangements and practical case studies, Design for manufacturing, User- friendly design
Course outcomes: At the end of the course the student will be able to: CO1. Describe mechatronic systems and overview of control systems & actuators. CO2. Identify and describe the different types of actuators used in mechatronic systems. CO3. Differentiate between various sensors, transducers and actuators and their applications. CO4. Identify and describe the different types of speed- and position feedback devices. CO5. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers. CO6. Discuss the importance of feedback in controlling physical systems with the use of examples. CO7. Explain the principle of operation of ac induction motor, dc motor, servomotor and stepper motor. CO8. Identify and describe the types of controllers used in mechatronic systems.
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module. ■
Textbook/ Textbooks
(1) W. Bolton, “Mechatronics” - Addison Wesley Longman Publication, 1999 2. HSU “MEMS and Microsystems design and manufacture” - Tata McGraw-Hill Education, 2002

Reference Books

1. Kamm, “Understanding Electro-Mechanical Engineering an Introduction to Mechatronics” - IEEE Press, 1 Edition, 1996
2. Shetty and Kolk “Mechatronics System Design” - Cengage Learning, 2010
3. Mahalik “Mechatronics” - Tata McGraw-Hill Education, 2003
4. HMT “Mechatronics” - Tata McGraw-Hill Education, 1998
5. Michel .B. Histand& David. Alciatore, “Introduction to Mechatronics & Measurement Systems”– . Mc Grew Hill, 2002
6. “Fine Mechanics and Precision Instruments” - Pergamon Press, 1971.