KARPAGAM ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)
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Ph.D. COURSE WORK SYLLABUS

MECHANICAL ENGINEERING

RESEARCH METHODOLOGY
(Effective from the academic year 2018-2019 onwards)

CODE: 18RME101

COURSE OBJECTIVES

1. To impart knowledge in the concept of problem identification and research methodology
2. To familiarize with basic of research and the research process
3. To demonstrate the different types of research and its applicability
4. To comprehend the knowledge of social research
5. To exhibit in sampling design and sampling techniques
6. To enrich the knowledge in writing a good research report.

COURSE OUTCOMES

1. Read, interpret, and critically evaluate social research.
2. Identify, explain, and apply the basic concepts of research, such as variables, operationalization, sampling, reliability, and validity.
3. Recognize the ethical issues involved in research, and practice ethical research standards.
4. Identify and explain the difference between quantitative, qualitative, and mixed methods research and what types of research questions can be answered with each method.
5. Use theory and previous research to create research questions and hypotheses and to identify and analyze the appropriate method and variables needed for research questions.
6. Use a variety of research methods through hands-on experience.

UNIT I
INTRODUCTION TO RESEARCH

Research Methodology: An Introduction –Meaning of research—Objectives of Research-Motivation in Research—Types of Research. -Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing. Impact Factor--Citation and Citation Index.

UNIT II
EXPERIMENTAL DESIGN

Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.

UNIT III

DATA COLLECTION, ANALYSIS AND INFERENCE

Binomial, Poisson, Normal, Exponential, Weibull and Geometric Distributions.Random sampling, stratified sampling, systematic sampling and cluster sampling. Student–t-test, F-test and $\chi 2$ test and their applications in research studies. Forecasting methods. Factor analysis, Cluster Analysis and Discriminant Analysis (Basic ideas only). Completely Randomized Design Randomized Block Design and Latin Square Design. Accuracy, Precision and error analysis.

UNIT IV

MULTIVARIATE STATISTICAL TECHNIQUES

Data Analysis – Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical (SPSS) Software Package in Research.

UNIT V

RESEARCH REPORT AND ETHICS IN RESEARCH

Significance of Report Writing- different steps in report writing-Layout of Research Report—Types of Reports-- Integral parts of a report – Precautions for writing a research report—Oral Presentation. Policy on academic Honesty and Integrity—academic cheating and Plagiarism. Opportunities to carry out research projects with funding/assistance from government agencies.

REFERENCE BOOKS:

1. Donald R. Cooper and Ramela S. Schindler, “Business Research Methods”, Tata McGraw-Hill, Publishing Company Limited, New Delhi, 2000.
2. Uma Sekaran, “Research Methods for Business”, John Wiley and Sons Inc., New York, 2000.
3. C.K.Kothari, “Research Methodology, methods and techniques”, New Age International, New Delhi, 2001.
4. Donald H.McBurney, “Research Methods”, Thomson Asia Pvt. Ltd. Singapore, 2002.
5. G.W.Ticehurst and A.J.Veal, “Business Research Methods”, Longman, 1999.
6. Ranjit Kumar, “Research Methodology”, Sage Publications, London, New Delhi, 1999.
7. Garg, B.L.Karadia, R.Agarwal, &F.Agarwal, U.K. 2002. “An Introduction to Research Methodology”, RBSA Publishers.
8. Panneerselvan.R., “Research Methodology”, Prentice hall of India, New Delhi, 2004.
9. Ganesan R, “Research Methodology for Engineers”, MJP Publishers, Chennai. 2011
10. Walpole R.A, Myers R.H, Myers S.L. and Ye King: “Probability & Statistics for Engineers and Scientists”, Pearson Prentice Hall, Pearson Education, Inc. 2007.
11. Graziano, A.M.andRaulin, M.,L.: “Research Methods – A Process of Inquiry”, Sixth Edition, Pearson, 2007.
12. Leedy, P.D.“Practical Research – Planning and Design”, Eighth Edition, Pearson.2005.

OPTIMIZATION TECHNIQUES
(Effective from the academic year 2018-2019 onwards)

CODE: 18RME201

COURSE OBJECTIVES

This course will enable the students

1. To introduce various optimization techniques.
2. To give exposure to nonlinear programming.
3. To give exposure to nonlinear programming with constraints.
4. To provide exposure to integer and dynamic programming.
5. To explain the network optimization techniques.
6. To enlighten the recent optimization techniques.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Formulate an optimization problem.
2. Apply the appropriate decision.
3. Formulate and solve a non-linear problem.
4. Determine the shortest path.
5. Describe nontraditional optimization techniques.
6. Apply newer optimization techniques for problem solving.

UNIT I
NONLINEAR OPTIMIZATION

Introduction – unconstrained optimization - one-dimensional optimization – elimination methods – Fibonacci method, golden section methods – interpolation methods – quadratic, direct route method – multivariable optimization - direct search methods – pattern search methods – univariate method, hooks and jeeves method, simplex method – descent methods – steepest descent, Newton methods.

UNIT II
CONSTRAINED NONLINEAR OPTIMIZATION

Direct methods – the complex method, cutting plane method – indirect methods – interior and exterior penalty function methods, Khun-Tucker conditions, Lagrangian method.

UNITIII
INTEGER AND DYNAMIC PROGRAMMING

Introduction to integer programming – solution techniques - graphical method, the branch and bound technique, gomary's cutting plane method, examples on the application in manufacturing / design systems – introduction to dynamic programming - bellman's principle of optimality, examples on the application on routing problem, inventory problem.

UNITIV

NETWORK OPTIMIZATION MODELS

Terminology of networks – the shortest route problem – the minimum spanning tree problem – the maximum flow problem – the minimum cost flow problem – the network simplex method.

UNITV

NON TRADITIONAL OPTIMIZATION MODELS

Introduction to non-traditional optimization, computational complexity – NP-hard, NP-complete, no free lunch theorem – working principles of simulated annealing, Tabu search, and neural networks, simple applications.Introduction to Genetic Algorithms, Ants Colony Algorithm, Particle Swarm Algorithm, Hybrid Algorithms, Simple Applications.

REFERENCE BOOKS:

1. Singiresu S Rao, "Engineering Optimization: Theory and Practice", Wiley-Interscience, Third Edition, 1996.
2. Kalyanmoy Deb, "Optimization for engineering design", Prentice Hall India Pvt. Ltd., New Delhi, 2000.
3. David E Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning",
4. Addison Wesley Pub Co., 1989.
5. Marco Dorigo and Thomas Stutzle, "Ant Colony Optimization", Prentice Hall of India, 2005.
6. Maurice Clerc, "Particle Swarm Optimization", ISTE, 2007
7. Dimitri P Bertsekas, "Dynamic Programming: Deterministic and Stochastic Models", Prentice Hall, 1987.
8. Stephen G Nash and ArielaSofer, "Linear and Nonlinear Programming", McGraw Hill College Div., 1995.
9. Fred Glover, Manuel Laguna and Fred Laguna, "Tabu Search", Kluwer Academic Publishers,1997.

COMPUTATIONAL METHODS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME202

COURSE OBJECTIVES

This course will enable the students

1. To understand the basic computational methods.
2. To solve problems by numerical approach
3. To understand the difference between various numerical methods.
4. To solve problems related to partial differential equations.
5. To solve problems related to parabolic and hyperbolic partial differential equations.
6. To fit the nonlinear curves through various curve fitting techniques.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Explain the concept of computational methods.
2. Solve problems using various numerical methods.
3. Find numerical solutions for partial differential equations.
4. Apply partial differential equations for heat transfer problems.
5. Solve wave equation.
6. Apply various techniques to fit curves.

UNIT I
INTRODUCTION TO COMPUTATIONAL METHODS

Examples, solving sets of equations, Gauss elimination method, Choleski method, Iterative methods, Relaxation method, system of non-linear equations- Newton Raphson method, computer programs.

UNIT II
NUMERICAL INTEGRATION

Newton-Cotes integration formulas, Trapezoidal rule, Simpson's rules, Gaussian quadrature, adaptive integration, cubic spline functions - Bezier curves and B-splines, computer programs. Boundary value problems and characteristic value problems:Shooting method, solution through a set of equations, derivative boundary conditions, Rayleigh-Ritz method, characteristic value problems, solution using characteristic polynomial method, Jacobi method, power method and Inverse power method.

UNIT III
NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

Laplace's equations, representations as a difference equation, Iterative methods for Laplace's equations, Poisson equation, derivative boundary conditions, irregular and non-rectangular grids, Matrix patterns, Sparseness, ADI method, applications to heat flow problems, computer programs.

UNIT IV

PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS

Explicit method, Crank-Nicholson method, derivative boundary condition, stability and convergence criteria, Parabolic equations in two or more dimensions, applications to heat flow problems, computer programs. Hyperbolic Partial differential equations**:**Solving wave equation by finite differences, stability of numerical method, method of characteristics, Wave equation in two space dimensions, computer programs.

UNIT V

CURVE FITTING AND APPROXIMATION OF FUNCTIONS

Least square approximation, fitting of non-linear curves by least squares, regression analysis, computer programs.

REFERENCE BOOKS:

1. Curtis F Gerald and Patrick O Wheatley, “Applied Numerical Analysis”, Pearson Education, 2002.
2. Rajasekaran S, “Numerical Methods in Science and Engineering – A Practical Approach”, Wheeler Publishing, 1999, Second Edition.
3. Douglas J Faires and Riched Burden, “Numerical Methods”, Brooks/Cole Publishing Company, 1998, Second Edition.
4. Steven C Chapra and Raymond P Canale, “Numerical Methods for Engineers with Software and Programming Applications”, Tata McGraw Hill Edition, 2004.
5. John H Mathews and Kurtis D Fink, “Numerical Methods using MATLAB”, Prentice Hall, 1998.
6. Ward Cheney and David Kincaid, “Numerical Mathematics and Computing”, Brooks/Cole Publishing Company, 1999, Fourth Edition.

MODELING SIMULATION AND ANALYSIS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME203

COURSE OBJECTIVES

This course will enable the students

1. To define the basics of simulation modeling and replicating the practical situations in organizations
2. To generate random numbers and random variates using different techniques.
3. To develop simulation model using heuristic methods.
4. To analysis of Simulation models using input analyzer, and output analyzer
5. To explain Verification and Validation of simulation model.
6. To develop Model for the manufacturing system

COURSE OUTCOMES

At the end of the course, students will be able to

1. Describe the basics of simulation modeling and analysis.
2. Describe the role of important elements of discrete event simulation and modeling paradigm.
3. Conceptualize real world situations related to systems development decisions, originating fromsource requirements and goals.
4. Develop skills to apply simulation software to construct and execute goal-driven system models.
5. Examine the simulation model of a problem.
6. Interpret the model and apply the results to resolve critical issues in a real-world environment.

UNIT I
INTRODUCTION TO SIMULATION

Definition – history - nature of computer modeling and simulation, limitations of simulation, areas of application. System and environment**:** Components of a system – types of simulation - discrete and continuous systems. Modeling approaches – simulation examples - manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.

UNIT II
RANDOM NUMBER GENERATION AND TESTING

Techniques for generating random numbers - midsquare method - midproduct method - constant multiplier technique - additive congruential method - linear congruential method – combined linear congruential generators – feedback shift register generators - tests for random numbers – frequency test - the Kolmogorov-Smirnov test, the chi-square test. Independence test – runs up and runs down, runs above and below the mean, autocorrelation.

UNIT III

RANDOM VARIATE GENERATION

Inverse transform technique - exponential distribution, uniform distribution, Weibull distribution, Triangular distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution. empirical discrete distribution - discrete uniform distribution - poisson distribution - geometric distribution - acceptance - rejection technique for poisson distribution - gamma distribution.

UNIT IV

STAGES IN MODEL BUILDING

Input modeling – data collection, identifying the distribution with data, parameter estimation, goodness of fit tests, selecting input models without data, models of arrival processes. verification and validation of simulation models – variance reduction techniques, antithetic variables, calibration and validation of models. output analysis –stochastic nature of output data, measures of performance and their estimation, output analysis for terminating simulation.

UNIT V

MANUFACTURING SYSTEMS MODELING

Objectives and performance measures – modeling system randomness – sources of randomness, machine downtime.

REFERENCES BOOKS:

1. Jerry Banks, John S, Carson II, Barry L Nelson and David M Nicol, “Discrete Event System Simulation”, Prentice Hall Inc., 2006.
2. Law A M, “Simulation Modeling and Analysis”, Tata McGraw Hill Companies Inc, 2008.
3. Gordon G, “Systems Simulation”, Prentice Hall Ltd., 2006.
4. Narsingh Deo, “System Simulation with Digital Computer”, Prentice Hall of India, 2007.
5. Francis Neelamkovil, “Computer Simulation and Modeling”, John Wiley and Sons, 1987.
6. Ruth M Davis and Robert M O'Keefe, “Simulation Modeling with Pascal”, Prentice Hall Inc., 1989.

QUALITY CONCEPTS IN DESIGN
(Effective from the academic year 2018-2019 onwards)

CODE: 18RME204

COURSE OBJECTIVES
This course will enable the students
1. To introduce basic quality concepts.
2. To give exposure to design for quality.
3. To provide exposure to failure mode effect analysis.
4. To explain the design of experiment concept.
5. To explain the statistical consideration in experimental design.
6. To introduce basics of reliability and enlighten design for six sigma process.

COURSE OUTCOMES
At the end of the course, students will be able to
1. Understand the basic quality concepts.
2. Find the root cause through failure mode effect analysis.
3. Design the experiments for analysis for product testing.
4. Analyze the product testing experiment results.
5. Analyze the problems with the aid of charts.
6. Create quality designs with the help of six sigma like quality concepts.

UNIT I
DESIGN FOR QUALITY
Quality Function Deployment -House of Quality-Objectives and functions-Targets Stakeholders-Measures and Matrices-Design of Experiments –design process Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

UNIT II
FAILURE MODE EFFECT ANALYSIS
Basic methods: Refining geometry and layout, general process of product embodiment checklist-Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling-Case study- computer monitor stand for a docking station.

UNIT III
DESIGN OF EXPERIMENTS
Design of experiments-Basic methods- Two factorial experiments-Extended method ,reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional

factorial design-Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA-ratio test, other indicators-residual plots, Advanced DOE method for product testing-Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization-Taguchi method.

UNIT IV
STATISTICAL CONSIDERATION AND RELIABILITY

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.- Reliability-Survival and Failure-Series and parallel systems-Mean time between failure.Weibull distribution

UNIT V
DESIGN FOR SIX SIGMA

Basics of SIX SIGMA –Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services L -45

REFERENCE BOOKS:

1. “Product Design Techniques in Reverse Engineering and New Product Development”, Kevin Otto & Kristin Wood, Pearson Education (LPE), 2001.
2. Product Design And Development, Karl T. Ulrich, Steven D. Eppinger, Tata Mcgraw-Hill-3rd Edition, 2003.
3. “The Management and control of Quality”-6th edition-James R. Evens, William M Lindsay Pubson south-western(www.swlearning.com)
4. “Fundamentals of Quality control and improvement”, 2nd edition, Amitava Mitra, Pearson Education Asia, 2002.

FINITE ELEMENT ANALYSIS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME205

COURSE OBJECTIVES

This course will enable the students

1. To formulate the problems related to bending of plates and shells.
2. To explain Numerical difficulties in solving nonlinear problems.
3. To understand the fundamental concepts of using FEA to model dynamic problems.
4. To understand the fundamental concepts of the theory of plasticity.
5. To understand the application of FEA concepts in fluid and heat transfer problems.
6. To select proper mesh refinement technique.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Analyze the problems related to bending of plates and shells.
2. Develop and build appropriate finite element models to solve complex engineering problems.
3. Critique numerical results and their validity.
4. Synthesize information and ideas for use in the evaluation process.
5. Apply FE methods for solving fluid mechanics and heat transfer.
6. Select the appropriate mesh refinement technique

UNIT I
BENDING OF PLATES AND SHELLS

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements- Application and Examples.

UNIT II
NON-LINEAR PROBLEMS

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure-Application in Metal Forming Process and Contact Problems.

UNIT III
DYNAMIC PROBLEM

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods – Explicit &Implict Methods- Lanchzos, Reduced method for large size system equations.

UNIT IV

FLUID MECHANICS AND HEAT TRANSFER

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT V

ERROR ESTIMATES AND ADAPTIVE REFINEMENT

Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.

REFERENCE BOOKS:

1. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
2. Cook R.D., "Concepts and Applications of Finite Element Analysis", John Wiley and Sons Inc., New York, 1989.
3. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.

COMPUTATIONAL FLUID DYNAMICS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME206

COURSE OBJECTIVES

1. To introduce Governing Equations of viscous fluidflows.
2. To introduce numerical modeling and its role in the field of fluid flow and heattransfer
3. To enable the students to understand the various discretization methods, solution procedures and turbulencemodeling.
4. To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speedcomputers.
5. To equip them with skills to solve convection and diffusionproblems.
6. To understand the importance continuity and momentum equations for different types of fluidflow

COURSE OUTCOMES

Upon completion of this course, the students can able

1. Identify, solve engineering problems by computational fluiddynamics.
2. Understand the importance of governing equations involved inCFD.
3. Formulate and solve problems in the field of fluid flow and heattransfer.
4. Solve the heat conduction problems using finite differencemethod.
5. Analyze and provide solutions for convection and diffusionproblems.
6. Develop continuity and momentum equations for different types of fluidflow.

UNIT I
GOVERNING DIFFERENTIAL EQUATIONS AND FINITE DIFFERENCE METHOD
Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II
CONDUCTION HEAT TRANSFER BY FINITE DIFFERENCE METHOD AND FINITE VOLUME METHOD
Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III
CONVECTION HEAT TRANSFER BY FINITE DIFFERENCE METHOD AND FINITE VOLUME METHOD
Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one-dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion.

UNIT IV

INCOMPRESSIBLE FLUID FLOW BY FINITE DIFFERENCE METHOD AND FINITE VOLUME METHOD

Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, SIMPLE, Computation of Boundary layer flow - Finite difference approach.

UNIT V

FINITE ELEMENT METHOD AND TURBULENCE MODELS

Introduction to finite element method – solution of steady heat conduction by FEM. Algebraic Models – One equation model, k – □ models - Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes – Prediction of flow in a sudden pipe contraction and pipe.

REFERENCE BOOKS:

1. Muralidhar, K.and Sundararajan, T., "Computational Fluid Flow and Heat Transfer",NarosaPublishing House, New Delhi, 2003.
2. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite volume Method", Pearson Education, Ltd., 2007.
5. Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier-Stokes Equation", Pineridge Press Limited, U.K., 1981.
6. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer "Hemisphere Publishing Corporation, New York, USA, 2012.
7. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1, Fundamental and GeneralTechniques", Springer – Verlag, 1991.
8. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2 ,Specific Techniques for Different Flow Categories", Springer – Verlag, 1988.
9. Bose, T.K., "Numerical Fluid Dynamics" Narosa Publishing House, 1997

TRIBOLOGY IN DESIGN
(Effective from the academic year 2018-2019 onwards)

CODE: 18RME301

COURSE OBJECTIVES

1. To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components.
2. To select proper grade lubricant for specific application.
3. To understand the principles of lubrication, lubrication regimes,
4. To understand the theories of hydrodynamic and the advanced lubrication techniques.
5. To introduce the concept of surface engineering and its importance in tribology.
6. To understand the behavior of Tribological components.

COURSE OUTCOMES

At the end of this course students will be able to

1. Explain the topography of the surfaces.
2. Discuss about the theory of sliding friction.
3. Elaborate in detail about the wear mechanism and various surface treatments, also able to explain about the international standards followed for friction and wear measurements.
4. Describe the application of various types of lubricants and explain in detail about the lubricant regimes.
5. Explain the theory of hydrodynamic and hydrostatic lubrication.
6. Understand the concepts of elasto hydrodynamics lubrication.

UNIT I
SURFACE INTERACTION AND FRICTION

Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact

UNIT II
WEAR AND SURFACE TREATMENT

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements

UNIT III
LUBRICANTS AND LUBRICATION REGIMES

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication-

Hydrodynamic lubrication — Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV

THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION

Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing-Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings

UNIT V

HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication heory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape ithin and outside contact zones-Film thickness and friction calculation- Rolling bearings- stresses and deflections-Traction drives

REFERENCE BOOKS:

1. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995
2. Cameron A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
3. Halling J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta&B.B.Ahuja ,“Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005.
6. G.W.Stachowiak& A.W .Batchelor , “Engineering Tribology”, Butterworth - Heinemann, UK,2005.

ADVANCED MANUFACTURING PROCESSES
(Effective from the academic year 2018-2019 onwards)

CODE: **18RME302**

COURSE OBJECTIVES

1. To provide knowledge on different aspects of powder metallurgy parameters.
2. To understand the importance of principle of advanced welding processes and its application.
3. To understand the importance of advanced forming processes and its application.
4. To familiarize the students to advanced manufacturing process for processing of different materials.
5. To acquaint the student to apply the suitable rapid prototyping mechanism for industry need.
6. To provide knowledge on optimum parametric for advanced manufacturing process.

COURSE OUTCOMES

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

1. Understand different aspects of powder metallurgy parameters.
2. Understand basic principle of advanced welding processes and its application.
3. Understand basic principle of advanced forming processes and its application.
4. Select the best suitable advanced manufacturing process for processing of different materials.
5. Apply the suitable rapid prototyping mechanism for industry need.
6. Select the optimum parametric for advanced manufacturing process

UNIT I
NEW MACHINING PROCESSES

(Non thermal energy) – Abrasive machining – water jet machining - ultrasonic machining – chemical machining – electro chemical machining – construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications .

UNIT II
NEWER MACHINING PROCESS

Wire cut EDM - Electro chemical machining – ECG - Electric discharge machining – construction – principle – types – control - circuits – tool design – merits, demerits & applications.

UNIT III
NEWER MACHINING PROCESS

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

UNIT IV
FABRICATION OF MICRO DEVICES

Semiconductors – films and film depurification – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process – Solid free form fabrication.

UNIT V
MICROFABRICATION TECHNOLOGY

Wafer preparation – monolithic processing – moulding – PCB board hybrid & mcm technology – programmable devices & ASIC – electronic material and processing.– steriolithography SAW devices, Surface Mount Technology.

REFERENCE BOOKS:

1. Seropekelpekijian&Stevan R. Schmid- "Manufacturing process and Engineering materials" – 2003
2. "Micro senors Mems & smart devices"- Julian W.Hardner – 2002
3. Brahem T. Smith, "Advanced machining", I.F.S. UK 1989.
4. Jaeger R.C., "Introduction to microelectronic fabrication", Addison Wesley, 1988.
5. Nario Taniguchi – "Nano technology" – Oxford University Press 1996.
6. Pandey P.C. & Shan HS,"Modern Machining Processes", Standard Publishing Co.,1980
7. More Madon, "Fundamentals of Micro fabrication", CRC Press, 1997

PHYSICS OF SOLAR ENGINEERING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME303

COURSE OBJECTIVES

1. To understand the basics of solar energy
2. To learn the origin of solar energy, tracking of the sunlight and atmospheric interaction of the solar radiation
3. To understand the working principle of the solar cells
4. To learn the working of different types of solar cells
5. To study about the different types of solar collectors
6. To learn about the energy storage systems

COURSE OUTCOMES

At the end of this course, the students will be able to

1. Know the basics of solar energy
2. Discuss about the origin of solar energy, how to track the sunlight
3. Explain the working of solar cells
4. Recognize the various types of solar cells
5. Identify the various types of solar collectors
6. Explain in brief about the energy storage systems

UNIT I
INTRODUCTION

Basics of solar energy - Brief History of solar energy utilization - Various approaches of utilizing solar energy - Blackbody radiation- Relation between radiation field energy density and radiation spectrum - Planck's formula in energy unit - Maximum spectral density - Planck's formula in wavelength unit -Wien displacement law - Stefan - Boltzmann law - Photoelectric effect - Einstein's theory of photons -Einstein's derivation of the black-body formula.

UNIT II
ORIGIN OF SOLAR ENERGY, TRACKING SUNLIGHT & ATMOSPHERIC INTERACTION

Basic parameters of the Sun - Measurement of the solar constant - The structure of the Sun - The origin of solar energy - Rotation and orbital motion of the Earth around the Sun - Solar time, sidereal time, universal standard time, local standard time - Equation of time - Intensity of sunlight on an arbitrary surface at any time - Interaction with the atmosphere - Absorption of the molecules - Air mass - Rayleigh scattering - Direct and scattered sunlight.

UNIT III
SOLAR CELLS
Formation of a pn – junction - Space charge and internal field - Quasi - Fermi levels - The Shockley diode equation - Structure of a solar cell - The solar cell equation - Fill factor and maximum power - Various electron - hole-pair recombination mechanisms - Crystalline silicon solar cells - Thin film solar cells: CIGS, Cite and a – silicon - Tandem solar cells - Dye - sensitized solar cells - Organic solar cells

UNIT IV
CONCENTRATION OF SOLAR ENERGY
Three types of imaging optics: trough or linear collectors, central receiver with heliostats, and parabolic dish concentrator with on - axis tracking- Solar thermal electricity using Stirling engine or Ranking engine - Solar photovoltaic's with concentration.

UNIT V
ENERGY STORAGE
Necessity of storage for solar energy- Chemical energy storage - Thermal energy storage - Thermal Flywheels - Compressed air- Rechargeable batteries.

REFERENCE BOOKS:

1. Duffie, J.A., and Beckman, W.A. "Solar Energy Thermal Process", John Wiley and Sons, NewYork, Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2007.
2. M. Stix, "The Sun An Introduction", Second Edition, Springer 2002.
3. Nelson, "The Physics of Solar Cells". Imperial College Press, 2003.
4. Rai, G.D., "Solar Energy Utilization", Khanna Publishers, N. Delhi, 2010.
5. Sukhatme S.P., "Solar Energy", Tata McGraw Hills P Co., 3rd Edition, 2008.
6. B.G. Streetman and S. Banerjee, "Solid State Electronic Devices", Sixth Edition, Prentice Hall, 2006.

WIND ENERGY TECHNOLOGIES
(Effective from the academic year 2018-2019 onwards)

CODE: **18RME304**

COURSE OBJECTIVES

This course enables the students to

1. Understand the basics of wind energy
2. Understand the measurement techniques
3. Discuss about the aerodynamic theory and types of wind turbines
4. Explain the working of gear coupled generator wind turbine components and their construction
5. Understand the construction and working of direct rotor coupled generator
6. Explain the controlling techniques of wind turbine

COURSE OUTCOMES

At the end of this course students will be able to

1. Explain the basics of the wind energy and its applications
2. Know how to measure the wind data and know about the various measuring instruments
3. Discuss in detail about the aerodynamic theory of wind turbines
4. Remember the working of gear coupled generator and wind turbine components
5. Explain the construction and working of direct rotor coupled generator
6. Describe the controlling technique of wind turbine

UNIT I

WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS

Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence. Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis

UNIT II

AERODYNAMICS THEORY & WIND TURBINE TYPES

Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator.

UNIT III

GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION

Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronisation System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for

Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor / Lightning Arrestors, Oscillation & Vibration sensing.

UNIT IV

DIRECT ROTOR COUPLED GENERATOR (MULTIPOLE)

Excited Rotor Synch. Generator / PMG Generator, Control Rectifier, Capacitor Banks, Step Up / Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits.

UNIT V

MODERN WIND TURBINE CONTROL & MONITORING SYSTEM

Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation &Maitenance for Product Life Cycle, Balancing technique (Rotor & Blade), FACTS control & LVRT & New trends for new Grid Codes.

REFERENCE BOOKS:

1. Freris, L.L., “Wind Energy Conversion Systems”, Prentice Hall, 1990
2. Kaldellis J.K, “Stand alone and Hybrid Wind Energy Systems”, CRC Press, 2010
3. Mario Garcia –Sanz, Constantine H. Houpis, “Wind Energy Systems”,CRC Press 2012
4. Spera, D.A., “Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering”,
5. ASME Press, 1994. 5. Duffie, A and Beckmann, W. A., “Solar Engineering of Thermal Processes”, John Wiley, 1991.
6. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, 1996.
7. Twidell, J.W. and Weir, A., “Renewable Energy Sources”, EFN Spon Ltd., 1983
8. John D Sorensen and Jens N Sorensen, “Wind Energy Systems”, Woodhead Publishing Ltd, 2011

ADVANCED HEAT AND MASS TRANSFER
(Effective from the academic year 2018-2019 onwards)

CODE: **18RME305**

COURSE OBJECTIVES

1. To develop the ability to use conduction and radiation heat transfer concepts for various applications
2. To understand the theories of convective heat transfer.
3. To understand the basic concepts of phase change processes and mass transfer.
4. To use numerical methods for solving heat transfer based problems
5. To understand the concepts of engine heat transfer correlation
6. To understand mass transfer concepts of engine and it correlation

COURSE OUTCOMES

Students will learn

1. To understand applications of the heat transfer in various thermal application
2. To discuss thermal analysis based problems
3. To explain about turbulent forces
4. To solve numerical problems in heat transfer
5. To describe the concepts of engine heat transfer correlation
6. To explain mass transfers in engine

UNIT I
CONDUCTION AND RADIATION HEAT TRANSFER

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - conduction with moving boundaries - radiation in gases and vapour.Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

UNIT II
TURBULENT FORCED CONVECTIVE HEAT TRANSFER

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k Є model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT III
PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER

Condensation with shears edge on bank of tubes - boiling – pool and flow boiling - heat exchanger – Є -- NTU approach and design procedure - compact heat exchangers.

UNIT IV

NUMERICAL METHODS IN HEAT TRANSFER

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation – steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER Algorithm.

UNIT V

MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines - compressors and turbines.

REFERENCEBOOKS:

1. YunusA.Cengal, “Heat and Mass Transfer – A practical Approach”, 3rd edition, Tata McGraw Hill, 2007.
2. Holman.J.P, “Heat Transfer”, Tata Mc Graw Hill, 2002.
3. Ozisik. M.N., “Heat Transfer – A Basic Approach”, McGraw-Hill Co., 1985
4. Incropera F.P. and DeWitt. D.P., “Fundamentals of Heat & Mass Transfer”, John Wiley & Sons, 2002.
5. Nag.P.K, “Heat Transfe”r, Tata McGraw-Hill, 2002
6. Ghoshdastidar. P.S., “Heat Transfer, Oxford University Press, 2004
7. Yadav, R., “Heat and Mass Transfer”, Central Publishing House, 1995.

ADDITIVE MANUFACTURING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME306

COURSE OBJECTIVES

1. To know the principle, methods, possibilities and limitations of Additive Manufacturing technologies.
2. to understand the concept of reverse engineering and cad modeling
3. To gain knowledge about the classification of liquid and solid based AM process
4. To educate the principles and application of powder based AM systems
5. To understand the concept of 3D printing
6. To educate about the case studies and application related AM process.

COURSE OUTCOMES

The students will be able to

1. Understand history, concepts and terminology of additive manufacturing
2. Apply the reverse engineering concepts for design development
3. Understand the classifications of additive manufacturing techniques
4. Understand about powder based AM systems
5. Explain the principle and applications of 3D printing
6. Understand the challenges associated with AM

UNIT I
INTRODUCTION

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits-Applications.

UNIT II
REVERSE ENGINEERING AND CAD MODELING

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III
LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object

Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV

POWDER BASED ADDITIVE MANUFACTURING SYSTEMS

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V

OTHER ADDITIVE MANUFACTURING SYSTEMS

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

REFERENCES BOOKS:

1. Gibson I., Rosen D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2. Chua C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010.
3. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
4. Liou L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, 2011.
5. Kamrani A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
6. Hilton P.D. and Jacobs, P.F., “Rapid Tooling: Technologies and Industrial Applications”, CRCpress, 2005.

AUTOMOBILE SYSTEMS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME307

COURSE OBJECTIVES

1. To understand about basics of automobile system
2. To understand the theoretical concepts of Engines
3. To understand the functions and designs of shaft and drives
4. To understand the terminology and working of suspension system
5. To understand applications of electronic in automobiles
6. To understand the purpose of alternate fuels and hybrid vehicles.

COURSE OUTCOMES

The students will be able to

1. Explain about specifications of automobile system
2. Explain the engine terminologies
3. Design and develop shaft and drives
4. Explain about braking systems
5. Explain about electronic systems in automobiles
6. Gain knowledge about alternate fuels and hybrid vehicles.

UNIT I
INTRODUCTION

Passenger, commercial vehicles, types and specifications, off highway vehicles. Resistance, power and torque curve, driving force against vehicle speed, acceleration and gradeability in different gears for a typical car or truck plotted from specifications. Calculation and plotting the curves of air, rolling and gradient resistances, driving force, engine power, speed, rear axle ratio. Torque and mechanical efficiency at different vehicle speeds.

UNIT II
ENGINE BASIC THEORY

Engine types and their operation, classification, Properties of I.C. engine fuels, actual cycle, air fuel cycle, combustion charts (equilibrium), two stroke engines, four stroke engine, characteristics of engines, air capacity of engine, valve timing diagram. Flywheel, clutch, gear box types, general function and design characteristics, decoupling of power, speed and torque characteristics of power transmission system.

UNIT III
SHAFT, DRIVE, WHEELS AND TYRES

Functional and design characteristics of propeller shaft, selection criteria for material and cross section of propeller shaft, need for differential and final drive. Use of different types of wheels and tyres, specification, materials.

UNIT IV

STEERING, SUSPENSION AND BRAKES

Effort multiplication and geometry in steering, types of springs used in suspension system, need for damping. Distribution of braking force on front and rear wheels, stopping distance and braking efficiency, introduction to ABS.

UNIT V

ELECTRICAL AND ELECTRONIC AND ALTERNATE FUEL SYSTEMS

Application of electricity in automobiles, starting, charging, lighting and accessory systems. Application of basic electronic components in automobiles. Introduction to alternate fuels – LPG, CNG, Bio fuels, Alcohol fuels. Introduction to electric, hybrid and fuel cell vehicles.

REFERENCE BOOKS:

1. W H & Anglin D L, "Automotive Mechanics", Tata McGraw Hill Publishing Company, 2004.
2. Robert Bosch "Automotive Hand book", 5th edition, 2004.
3. Ganesan V , "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2003.
4. Mathur L and Sharma R P, "Internal Combustion Engines", Dhanpat Rai Publications
5. (P), Ltd, New Delhi, 2002.
6. Heinz Heisler, "Advanced Engine Technology", SAE 1995.
7. Richard Stone, "Introduction to IC Engines", 2nd edition, Macmilan,1992.
8. Obert E F, "Internal Combustion Engine analysis and Practice", International Text Book Co., Scranton, Pennsylvania, 1988.
9. John B Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill International Editions, 1988.

LEAN MANUFACTURING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME308

COURSE OBJECTIVES

1. To study the various concept lean manufacturing (LM).
2. To understand the tools and methodologies in LM system
3. To understand the concepts of value stream mapping
4. To understand the principles of manufacturing and optimization technology to improve production
5. To study various cases based on assembly line
6. To understand the process involves in implementing lean

COURSE OUTCOMES

The students will be able to

1. Explain about lean manufacturing
2. Apply lean manufacturing tools in industries
3. Identify the scenarios in value stream mapping
4. Apply optimization techniques in industries related problems
5. Solve production related issues
6. implement lean manufacturing in industries

UNIT I
INTRODUCTION TO LEAN MANUFACTURING

Objectives of lean manufacturing-key principles and implications of lean manufacturing- traditional Vs lean manufacturing. Lean Manufacturing Concepts: Value creation and waste elimination- main kinds of waste- pull production-different models of pull production-continuous flow-continuous improvement / Kaizen- worker involvement -cellular layout- administrative lean.

UNIT II
LEAN MANUFACTURING TOOLS AND METHODOLOGIES

Standard work -communication of standard work to employees -standard work and flexibility -visual controls-quality at the source- 5S principles -preventative maintenance-total quality management-total productive maintenance -changeover/setup time -batch size reduction -production leveling.

UNIT III
VALUE STREAM MAPPING

The as-is diagram-the future state map-application to the factory simulation scenario-line balancing -Poke Yoke -Kanban – overall equipment effectiveness.

UNIT IV

JUST IN TIME MANUFACTURING

Introduction - elements of JIT - uniform production rate - pull versus push method- Kanban system - small lot size - quick, inexpensive set-up - continuous improvement. Optimised production technology. One-piece flow: Process razing techniques – cells for assembly line – case studies.

UNIT V

IMPLEMENTING LEAN

Road map-senior management Involvement-best practices. Reconciling lean with other systems: Toyota production system-lean six sigma-lean and ERP-lean with ISO9001:2000.

REFERENCE BOOKS:

1. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2003.
2. Michael L George, David T Rowlands, Bill Kastle, “What is Lean Six Sigma”, McGraw Hill, New York, 2004.
3. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.
4. Kenichi Sekine, “One-Piece Flow”, Productivity Press, Portland, Oregon, 1992.
5. Alan Robinson “Continuous Improvement in Operations”, Productivity Press, Portland, Oregon, 1991.
6. Joseph A De Feo, William W Bearnard , “Juran Institute’s Six Sigma Break Through and Beyond”, Tata McGraw Hill Edition, New Delhi, 2004.
7. Richard B Chase F Robert Jacobs and Nicholas J Aquilano, “Operations Management for Competitive Advantage”, McGraw Hill/Irwin; Tenth Edition, 2003.
8. Poke - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 1992.

SURFACE ENGINEERING
(Effective from the academic year 2018-2019 onwards)
CODE:18RME309

COURSE OBJECTIVES

1. To impart knowledge in the friction aspects of machine components
2. To understand the material properties which influence the tribological characteristics of Surfaces
3. To understand the principle and classifications of corrosion.
4. To understand the purpose of surface treatment.
5. To understand procedure and classification involves in surface coating
6. To understand the important and classification of engineering materials

COURSE OUTCOMES

The students will be able to

1. Gain knowledge about friction and its application
2. Explain about wear behavior of materials
3. Recognize types of corrosion and its control procedures
4. Apply surface treatment on material surface
5. Apply surface coating based on the applications of material
6. Describe about the engineering materials and its applications

UNIT I
FRICTION

Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact

UNIT II
WEAR

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear- Laws of wear – Theoretical wear models – Wear of metals and non metals - International standards in friction and wear measurements

UNIT III
CORROSION

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT IV

SURFACE TREATMENTS

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

UNIT V

ENGINEERING MATERIALS

Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology Nano Tribology.

REFERENCE BOOKS:

1. G.W.Stachowiak& A.W .Batchelor , “Engineering Tribology”, Butterworth-Heinemann, UK, 2005.
2. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons ,UK,1995
3. Halling, J. (Editor) – “Principles of Tribology”, Macmillian – 1984.
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta&B.B.Ahuja, “Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005.
6. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985

INDUSTRIAL ROBOTICS & EXPERT SYSTEMS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME310

COURSE OBJECTIVES

1. Learn about the types of robots used in material handling systems.
2. Understand the use of vision systems in automation systems.
3. Gain knowledge on the different methods of material handling.
4. Apply knowledge about choosing sensors for robotics.
5. To design the methods of Robot Programming
6. To design robots in various industrial application.

COURSE OUTCOMES

The Student will be able to

1. Differentiate the various types of Industrial Robots and their architecture.
2. Apply the concepts of image processing for robotic inspection systems.
3. Analyze the applications of robots in various industrial application.
4. Design and fabricate simple grippers for pick and place application.
5. Identify the right Robot for a given industrial application.
6. Select the right material handling system for a given application

UNIT 1
INTRODUCTION AND ROBOT KINEMATICS

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT-II
ROBOT DRIVES AND CONTROL

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT-III
ROBOT

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT-IV

ROBOT CELL DESIGN AND APPLICATION

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial applications of Robots.

UNIT-V

ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TEXT BOOK:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics Control, Sensing,Vision and Intelligence”, Mc Graw Hill, 1987.

REFERENCE BOOKS:

1. Yoram Koren,” Robotics for Engineers’ Mc Graw-Hill, 1987.
2. Kozyrey, Yu. “Industrial Robots”, MIR Publishers Moscow, 1985.
3. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, “Robotics Engineering-An Integrated Approach”, Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R.” Robotics Technology and Flexible Automation”, Tata Mc Graw-Hill, 1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, “Industrial Robotics Technology, Programming and Applications”, Mc Graw-Hill, Int. 1986.
6. Timothy Jordanides et al, “Expert Systems and Robotics”, Springer-Verlag, NewYork, May 1991.

ADVANCED THERMODYNAMICS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME311

COURSE OBJECTIVES

1. Identify the unique vocabulary associated with thermodynamics.
2. Explain the basic concepts of thermodynamics like system, properties, equilibrium, pressure, specific volume, temperature, zeroth law of thermodynamics, temperature measurement and temperature scales.
3. Calculate thermodynamic properties using tables of thermodynamic properties and analyze the processes on T-v diagrams to solve advanced engineering problems.
4. State and apply the first law of thermodynamics for closed and open systems undergoing different thermodynamic processes.
5. Evaluate the performance of steam power plants, refrigeration plants and their components using the first law of thermodynamics for open systems
6. Apply the inequality ofClausius and establish the property entropy of a system.

COURSE OUTCOMES

1. To apply the knowledge of mathematics, science and engineering fundamentals to model the energy conversion phenomenon.
2. To identify and formulate power production based on the fundamentals laws of thermal engineering.
3. To instill upon to envisage appropriate experiments related to heat engines.
4. To investigate the effectiveness of energy conversion process in mechanical power generation for the benefit of mankind.
5. To appreciate concepts learnt in fundamentals laws of thermodynamics from which learning ideas how to sustain in energy crisis and think beyond curriculum in the field of alternative and renewable sources of energy.
6. To communicate effectively the concepts of internal combustion engines and try to think beyond curriculum in alternative sources of energy.

UNIT I
AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS

Reversible work - availability - irreversibility and second – law efficiency for a closed system and steady – state control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwell relations. Generalized relations for changes in entropy - internal energy and enthalpy - generalized relations for Cp and CV Clausius Clayperon equation, Joule – Thomson coefficient.Bridgeman tables for thermodynamic relations.

UNIT II
REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS

Different equations of state – fugacity – compressibility - principle of corresponding States - Use of generalized charts for enthalpy and entropy departure - fugacity coefficient,Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition. Partial molar properties.Real gas mixtures - Ideal solution of real gases and liquid - activity - equilibrium in multi phase systems - Gibbs phase rule for non – reactive components.

UNIT III
CHEMICAL THERMODYNAMICS AND EQUILIBRIUM

Thermochemistry - First law analysis of reacting systems - Adiabatic flame temperature – entropy change of reacting systems - Second law analysis of reacting systems - Criterion for reaction equilibrium.Equilibrium constant for gaseous mixtures - evaluation of equilibrium composition.

UNIT IV
STATISTICAL THERMODYNAMICS

Microstates and Macrostates - thermodynamic probability - degeneracy of energy levels - Maxwell – Boltzman, Fermi – Diarc and Bose – Einstein statistics - microscopic interpretation of heat and work, evaluation of entropy, partition function, calculation of the Macroscopic properties from partition functions.

UNIT V
IRREVERSIBLE THERMODYNAMICS

Conjugate fluxes and forces - entropy production Onsager's reciprocity relations - thermo – electric phenomena, formulations.

TEXT BOOKS:

1. Kenneth WarkJt.m, Advanced Thermodynamics for Engineers, McGrew – Hill Inc., 1995.
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 1988.
3. Holman, J.P., Thermodynamics, Fourth Edition, McGraw – Hill Inc., 1988.

REFERENCE BOOKS:

1. Smith, J.M. and Van Ness., H.C., Introduction to Chemical Engineering Thermodynamics, Fourth Edition, McGraw – Hill Inc., 1987.
2. Sonntag, R.E., and Van Wylen, G, "Introduction to Thermodynamics, Classical and StatisticalThemodynamics", Third Edition, John Wiley and Sons, 1991.
3. Sears, F.W. and Salinger G.I., "Thermodynamics, Kinetic Theory and StatisticalThermodynamics", Third Edition, Narosa Publishing House, New Delhi, 1993.
4. DeHotf, R.T., "Thermodynamics in Materials", Science, McGraw – Hill Inc., 1993. Rao,Y.V.C.,
5. "Postulational and Statistical Thermodynamics", Allied Publisher Limited, New Delhi, 1999.

ADVANCED INTERNAL COMBUSTION ENGINEERING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME312

COURSE OBJECTIVES

1. To make familiar with the design and operating characteristics of engines
2. To understand the basic principles of combustion
3. To gain knowledge in the principles of SI engine combustion
4. To understand the concepts of CI engine system
5. To understand the basic concepts of gas turbine combustion and the latest technologicaladvances in low temperature combustion
6. To design the alternate fuels.

COURSE OUTCOMES

1. Given an engine design specification, predict performance and fuel economy trends
2. Apply basic concepts in the design of combustion systems
3. Able to design SI engine system
4. Develop an understanding of real-world diesel engine design issues
5. Develop an ability to optimize future engine design for better fuel economy,
6. Develop an ability to optimize performanceand emissions.

UNIT I
SPARK IGNITION ENGINES

Spark ignition Engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – factors affecting knock – Combustion chambers.

UNIT II
COMPRESSION IGNITION ENGINES

States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers –Fuel spray behaviour – spray structure, spray penetration and evaporation – air motion – Introduction to Turbo charging.

UNIT III
POLLUTANT FORMATION AND CONTROL

Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

UNIT IV
ALTERNATIVE FUELS
Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

UNIT V
RECENT TRENDS
Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – laser Doppler, Anemometry.

TEXT BOOK

1. K.K. Ramalingam, “Internal Combustion Engine Fundamentals”, Scitech Publications, 2002.

REFERENCE BOOKS

1. R.B.Mathur and R.P. Sharma, “Internal combustion Engines”.
2. V. Ganesan, “Internal Combustion Engines”, II Edition, TMH, 2002.
3. Duffy Smith, “Auto fuel Systems”, The Good Heart Willox Company, Inc., 1998

REFRIGERATION SYSTEMS DESIGN
(Effective from the academic year 2018-2019 onwards)

CODE:18RME313

COURSE OBJECTIVES

1. To provide a fundamentals of refrigeration systems
2. To accustom with various methods of production of cold with refrigeration systems
3. To impart knowledge about applications of refrigeration systems
4. To familiarize with industrial protocols, regulations in the field in refrigeration.
5. To design refrigeration system with respect to surroundings.
6. To design thermo Electric Refrigeration and Air Refrigeration cycles.

COURSE OUTCOMES

Students will be able to

1. Understand the principles and remember the applications of refrigeration systems
2. Analyze performance of vapor compression refrigeration system
3. Study the working principles of vapor absorption, thermoelectric, steam jet refrigerationsystem.
4. Create capacity to compute heating / cooling load
5. Create the eco-friendly refrigerants.
6. demonstrate an understanding of the engineering and operation of vaporcompression and possibly heat-driven refrigeration systems and evaporative cooling systems andunderstand contemporary issues of ozone depletion and global warming potential with respect torefrigeration systems.

UNIT I
REFRIGERATION CYCLES - ANALYSIS

Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle- conditions for high COP-deviations from ideal vapor compression cycle,MultipressureSystems, Cascade Systems-Analysis.

UNIT II
MAIN SYSTEM COMPONENTS

Compressor- Types,performance, Characteristics of Reciprocating Compressors, Capacity Control, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behavior with fluctuating load.

UNIT III
REFRIGERANTS

Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal / Kyoto protocols-Eco Friendly Refrigerants. Different Types of Refrigeration Tools , Evacuation and Charging Unit , Recovery and Recycling Unit , Vacuum Pumps.

UNIT IV
SYSTEM BALANCING & CONTROLS
Estimation of Cooling Load, System Equilibrium and Cycling Controls, Electric Circuits in-Refrigerators, Window A/C, Types of motors, Relays.

UNIT V
OTHER REFRIGERATION CYCLES
Vapor Absorption Systems-Aqua Ammonia &LiBr Systems, Steam Jet Refrigeration Thermo Electric Refrigeration and Air Refrigeration cycles.

TEXT BOOKS:

1. Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version (2001).
2. Stoecker W.F., Refrigeration and Air conditioning, McGraw-Hill Book Company, 1989.

REFERENCE BOOKS:

1. Jordan and Priester , Refrigeration and Air conditioning 1985.
2. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1985.
3. Langley , Billy C., 'Solid state electronic controls for HVACR' pentice-Hall 1986.

COMPOSITE AND POLYMER MATERIALS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME314

COURSE OBJECTIVES

1. Explain the behavior of constituents in the composite materials
2. Enlighten the students in different types of reinforcement
3. Develop the student's skills in understanding the different manufacturing methods available for composite material.
4. Illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.
5. To design the liquid state fabrication methods
6. To apply the knowledge about recycling of PMC

COURSE OUTCOMES

Upon completion of this course the student will be able to

1. Explain the mechanical behavior of layered composites compared to isotropicmaterials.
2. Apply constitutive equations of composite materials and understand mechanicalbehavior at micro and macro levels.
3. Determine stresses and strains relation in composites materials.
4. Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products.
5. Analyse the elastic properties and simulate the mechanical performance of compositelaminates; and understand and predict the failure behaviour of fibre-reinforced composites
6. Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project

UNIT I
PROPERTIES OF POLYMERS

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics – Applications – Merits and Disadvantages.

UNIT II
PROCESSING OF POLYMERS

Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Mechanical Fasteners – Thermal bonding – Press Fitting.

UNIT III
INTRODUCTION TO FIBRES AND COMPOSITE MATERIALS
Fibres – Fabrication, Structure, properties and applications - Glass, Boron, carbon, organic, ceramic and metallic fibers whiskers– Matrix materials structure – polymers, – metals and ceramics – Physical and chemical properties.

UNIT IV
PROCESSING OF POLYMER MATRIX COMPOSITES
Open mould process, bag moulding, compression moulding with BMC and SMC filament winding – pultrusion – centrifugal casting – injection moulding – structure, properties and application of PMC's – Carbon Matrix Composites - Interfaces – Properties – recycling of PMC.

UNIT V
PROCESSING OF METAL MATRIX COMPOSITES AND CERAMIC MATRIX COMPOSITES
Solid state fabrication techniques – diffusion bonding – powder metallurgy techniques plasma spray, chemical and physical vapour deposition of matrix on fibres Chemical vapour infiltration – Sol gel – liquid state fabrication methods – infiltration – squeeze, casting – rheo casting – compocasting - Interfaces properties– application of MMC and ceramic matrix composites.

REFERENCE BOOKS:

1. Krishnan K Chawla, "Composite Materials Science and Engineering", International Edition, Springer, 2006
2. Harold Belofsky, "Plastics, Product Design and Process Engineering", Hanser Publishers, 2002.
3. Bera.E and Moet.A, "High performance polymers", Hanser Publishers, 2001.
4. Rauwendaal,C., "Polymer extrusium", Hanser publishers, 2000.
5. Rosatao, D.V. "Blow moulding",HandBook, Hanser Publishers, 1989.
6. Seamour, E.B. "Modern Plastics Technology", Prentice Hall, 2002
7. Mallick, P.K. and Newman.S., "Composite Materials Technology", Hanser Publishers, 2003

ADVANCES IN CASTING AND WELDING PROCESSES
(Effective from the academic year 2018-2019 onwards)

CODE:18RME315

COURSE OBJECTIVES

1. To familiarize the students to apply various design considerations in casting, gating and risering.
2. To develop an understanding of casting metallurgy like solidification, shrinkage and degasification.
3. To explain about the recent trends in casting.
4. To understand the concept foundry layout and pollution control in foundry.
5. To study and acquire knowledge of welding metallurgy and design aspects of welding
6. To provide an overview of recent trends in welding and various welding methods.

COURSE OUTCOMES

Upon completion of this course, the students can able to

1. Apply suitable design considerations in casting, gating and risering.
2. Identify the effect of solidification, shrinkage and degasification.
3. Select the type of casting process.
4. Work with various foundry layouts and pollution control.
5. Identify the effect of metallurgy in welding and design aspects.
6. Select the type of welding method and recent trends.

UNIT I
CASTING DESIGN

Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering

UNIT II
CASTING METALLURGY

Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification — Degasification of the melt-casting defects – Castability of steel , Cast Iron, Al alloys , Babbit alloy and Cu alloy.

UNIT III
RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT

Shell moulding, precision investment casting, CO_2moulding, centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes.

Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry — Computer aided design of casting.

UNIT IV

WELDING METALLURGY AND DESIGN

Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.

UNIT V

RECENT TRENDS IN WELDING

Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electroslag welding- narrow gap, hybrid twin wire active TIG – Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes – Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

REFERENCE BOOKS:

1. ASM Handbook, Vol 15, “Casting”, 2004
2. ASM Handbook vol.6, “Welding, Brazing & Soldering”, 2003
3. Parmer R.S., “Welding Engineering and Technology”, Khanna Publishers,2002
4. Srinivasan N.K., “Welding Technology”, Khanna Tech Publishers, 2002
5. Heineloper& Rosenthal, “Principles of Metal Casting”, Tata McGraw Hill, 2000.
6. Jain P.L., “Principles of Foundry Technology”,TataMcGrawHill Publishers, 2003
7. Carrry B., “Modern Welding Technology”, Prentice Hall Pvt Ltd., 2002
8. Iotrowski – “Robotic welding – A guide to selection and application” – Society of Mechanical Engineers, 1987.
9. Schwariz, M.M. – “Source book on innovative welding processes” – American Society for Metals (OHIO), 1981
10. Cornu.J. “Advanced welding systems” – Volumes I, II and III, JAICO Publishers,1994.
11. Lancaster.J.F. – “Metallurgy of welding” – George Alien & Unwin Publishers, 1980

MANUFACTURING SYSTEMS ENGINEERING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME316

COURSE OBJECTIVES

1. To explain the principles of manufacturing systems and manufacturing models.
2. To understand the concept of various flow shop systems.
3. To provide knowledge on different types of layouts and cellular systems.
4. To expose the students to know about flexible manufacturing and inspection systems.
5. To explain the construction features of different types of material handling systems.
6. To provide knowledge on material storage and retrieval systems.

COURSE OUTCOMES

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

1. Explain the principles and types of manufacturing systems and models.
2. Discuss about the constructional features of flow shop systems.
3. Describe the construction of layouts, layout planning and design procedures, cellular and group technology.
4. Illustrate the concept of flexible manufacturing and inspection systems.
5. Describe the constructional features of various material handling systems.
6. Explain about material storage and retrieval systems.

UNIT I
MANUFACTURING SYSTEMS AND MODELS

Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model uses, model building.

UNIT II
FLOW SHOP SYSTEMS

Assembly lines - reliable serial systems - approaches to line balancing – largest candidate rule, kilbridge& wester method, ranked positional weight heuristic, COMSOAL, – sequencing mixed models. Transfer lines and general serial systems – paced lines with & without buffers, unpaced lines.

UNIT III
FACILITY LAYOUT AND CELLULAR SYSTEMS

Types of layouts – advantages, limitations, systematic layout planning, layout design procedures - quadratic assignments approach, graph theoretic approach, robotics and automated assembly.

Cellular Systems- Group technology – coding schemes – assigning machines to groups – production flow analysis, binary ordering algorithm, single pass heuristic, similarity coefficient method.

UNIT IV
FLEXIBLE MANUFACTURING SYSTEMS
System components – planning and control hierarchy – system design, system setup, scheduling and control – flow shop scheduling, job shop scheduling, Flexible inspection systems.

UNIT V
MATERIAL HANDLING AND STORAGE
Material handling principles, equipment – conveyor analysis, AGV systems, Warehousing – warehouse components, analysis of storage and retrieval systems, carousal storage systems, Introduction to Material handling and storage software.

REFERENCE BOOKS:

1. Ronald G Askin, "Modeling and Analysis of Manufacturing Systems", John Wiley and Sons, Inc,1993.
2. Viswanatham N and Narahari Y "Performance Modeling of Automated Manufacturing Systems", Prentice Hall Inc.,1992.
3. Mengchu Zhou, "Modeling, Simulation and Control of Flexible Manufacturing Systems: A Petri Net Approach", World Scientific Publishing Company Pvt. Ltd., 2000.
4. Jean Marie Proth and XiaolanXie, "Petri Nets: A Tool for Design and Management of Manufacturing Systems", John Wiley and Sons, New York,1996.
5. Brandimarte P and Villa A, "Modeling Manufacturing Systems" Springer Verlag, Berlin, 1999

SUPPLY CHAIN MANAGEMENT
(Effective from the academic year 2018-2019 onwards)

CODE:18RME317

COURSE OBJECTIVES

1. Toknowthe objectives of supply chain management and supply chain network design.
2. To impart knowledge, need for inventorymanagement.
3. To expose the students to know about strategic alliance.
4. To understand the role of distribution in supply chain and various strategies followed.
5. To expose the students to know about the customer value and global supply chains.
6. Toknow about the various information technologies needed for SCM.

COURSE OUTCOMES

On completion of this course, students will learn about

1. Basics and objectives of SCM and supply chain network design
2. Understand the need for inventorymanagement
3. Describe about the various strategicalliance.
4. Illustrate the role of distribution in supply chain.
5. Explain about the various issues in the internationalSCM.
6. Get knowledge in information technology involved inSCM.

UNIT I
INTRODUCTION AND SUPPLY CHAIN NETWORK DESIGN

Definition, house of supply chain – customer satisfaction, integration, coordination - decision phases in a supply chain, objectives of SCM, examples of supply chains, supply chain drivers, supply chain performance measures. SUPPLY CHAIN NETWORK DESIGN- Data collection – data aggregation, transportation modes and rates, mileage estimation, warehouse costs, warehouse capacity, potential warehouse locations, service level requirements and future demand. Network design in the supply chain – factors influencing the network design, framework for network design decisions, models for facility location and capacity allocation – capacitated plant location model, gravity location model, allocating demand to production facilitates, simultaneous location of plants and warehouses – impact of uncertainty on network design.

UNIT II
INVENTORY MANAGEMENT AND STRATEGIC ALLIANCE

Single warehouse inventory model - cycle inventory – economies of scale to exploit fixed costs, quantity discounts, short term discounting, multi-echelon inventory, example problems. managing uncertainty – safety inventory in the supply chain –safety level estimation, impact of supply

uncertainty, impact of aggregation, impact of replenishment policies, managing safety inventory in multi echelon supply chain, managing safety inventory in practice – product availability – optimal level, affecting factors, supply chain contracts – risk pooling – examples. value of information – Bullwhip effect, information and supply chain technology. STRATEGIC ALLIANCE - Framework for strategic alliance - 3PL and 4PL – retailer-supplier partnerships – distribution integration – procurement and outsourcing – benefits, make/buy decisions, E-Procurement, supplier relationship management – supplier scoring and assessment, supplier selection and contracts – E-Business and the supply chain. design for logistics- Reverse logistics –Cases in Paper industry – Furniture industry – supplier integration into new product development – mass customization.

UNIT III
DISTRIBUTION NETWORK DESIGN AND STRATEGIES
Role of distribution in supply chain – distribution network design – factors influencing distribution network design. push strategy – pull strategy – Kanban replenishment systems, types, implementation, and push–pull strategy – demand driven strategy – impact of internet on supply chain strategy. distribution networks in practice – direct shipment, cross docking, warehousing, transshipment.

UNIT IV
CUSTOMER VALUE AND GLOBAL SUPPLY CHAINS
Customer value – dimensions, strategic pricing, customer value measures, information technology and customer value – customer relationship management. global supply chains – introduction, driving factors, risks and advantages, issues, regional differences in logistics.

UNIT V
INFORMATION TECHNOLOGY FOR SCM
Goals – standardization – infrastructure – interface devices, communications, databases, system architecture – system components – integrating the supply chain information technology - DSS for supply chain management.

REFERENCE BOOKS:

1. Simchi – Levi Davi, Kaminsky Philip and Simchi-Levi Edith, “Designing and Managing the Supply Chain”, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2003.
2. Chopra S and Meindl P, “Supply Chain Management: Strategy, Planning, and Operation”, Prentice Hall India Pvt. Ltd, New Delhi, 2007.
3. Robert B Handfield and Ernest L Nichols, “Introduction to Supply Chain Management”, Prentice Hall, Inc. New Delhi, 1999.
4. Sahay B S, “Supply Chain Management”, Macmillan Company, 2000.
5. David Brunt and David Taylor, “Manufacturing Operations and Supply Chain Management : The Lean Approach”, Vikas Publishing House, New Delhi, 2001.
6. Hartmud Stadler and Christoph Kilger, “Supply Chain Management and Advanced Planning: Concepts, Models, Software”, Springer-Verlag, 2000.

7. David F Ross, "Introduction to E-Supply Chain Management", CRC Press, 2003

ENGINEERING METALLURGY
(Effective from the academic year 2018-2019 onwards)

CODE:18RME318

COURSE OBJECTIVES

1. To impart knowledge on special steel and their types.
2. To understand the types and properties of age hardenable alloys.
3. To impart knowledge on dielectric materials.
4. To familiarize on selection of semiconductor materials.
5. To learn about the biomaterials.
6. To impart knowledge on intelligent materials.

COURSEOUTCOMES

Learners should be ableto

1. Identify the special steel and their types.
2. Describe the types and properties of age hardenable alloys.
3. Explain the various dielectric materials for suitable applications.
4. Identify and select suitable semiconductor materials.
5. Understand the fundamentals of biomaterials.
6. Describe about the intelligent materials.

UNIT I
SPECIAL STEEL

High strength low alloy (HSLA) steel, Dual phase steel, Duplex stainless steel, TRIP steel, Maraging steel, High speed steel, Stainless steel: ferritic, austenitic and martensitic. Precipitation & dispersion hardenable materials,

UNIT II
AGE HARDENABLE ALLOYS

Al-Cu alloys, Al-Fe-V-Si alloys. Super alloys: Ni, Fe and Co based super alloys, Ti based alloys & their thermo mechanical treatment, Nano materials: Synthesis, properties and applications. ; Non-structural materials: Dielectric materials; dielectric constant and polarization, linear dielectric materials, capacitors and insulators, non-linear dielectrics, pyro, piezo and ferro-electrics properties;

UNIT III
SEMICONDUCTOR

Direct and indirect band gap, band diagrams, applications of semiconductors, degenerate and non-degenerate semiconductors, extrinsic and intrinsic semiconductors. Superconducting materials, Optical &Photoionic materials, electron-hole-recombination.

UNIT IV
BIOMATERIALS
Property requirements for biomaterials, concept of biocompatibility, important biometallic alloys; Ti based, stainless steel. Intelligent materials.

TEXT BOOKS

1. W.F. Smith, “Principles of Materials Science and Engineering”,McGraw Hill, New York (1994).
2. W.D. Callister, “An Introduction Materials Science & Engineering”, John Wiley & Sons (2007).

REFERENCE BOOKS

1. V. Raghavan, “Material Science and Engineering”, Prentice Hall of India, 2004.
2. R.Sharma, Sharma, “Heat Treatment: Principles and techniques”, Prentice Hall of India, (2004).

INDUSTRIAL SAFETY

(Effective from the academic year 2018-2019 onwards)

CODE:18RME319

COURSE OBJECTIVES

1. To acquaint the student with the need and awareness of the safetyconcepts
2. To understand the importance of various safety techniques involved in industrialsector
3. To introduce the concepts of accident zone and prepare reports related toit.
4. To equip them with skills to conduct basic safety inspections using strategies that theyhave developed
5. To develop an understanding ofsafetymonitoring.
6. To understand the effects of chemical hazards and overview of factories act.

COURSE OUTCOMES

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

1. Understand the need and awareness of the safetyconcepts
2. Understand the various safety techniques involved in industrialsector
3. Record and investigate the accident zone and prepare reports related toit.
4. Conduct basic safety inspections using strategies that theyhave developed
5. Identify and demonstrate working of safetymonitoring
6. Train about the education and training based onsafety and factories act

UNIT I
SAFETY CONCEPT

Evolution of modern safety concept- safety policy - Safety Organization - Safety Committee - budgeting for safety. Safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign

UNIT II
CONCEPT OF AN ACCIDENT

reportable and non reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – cost of accident. Machine Guarding, Guarding of hazards

UNIT III
SAFETY

Machine Guarding types and its application – Safety in welding and Gas cutting – Safety in Manual and Mechanical material handling Safety in use of electricity

UNIT IV

TOXICITY

TLV- Types of Chemical Hazards-Occupational diseases caused by dust, fumes, gases, smoke and solvent hazards- control measures Fire triangle- Types of fire - first aid firefighting equipment – flammability limit- LPG safety Overview of factories act 1948 – OHSAS-18000

REFERENCE BOOKS:

1. "Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982
2. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973
3. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
4. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
5. John Ridley, "Safety at Work", Butterworth & Co., London, 1983.

PRODUCT DESIGN AND TOOLING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME320

COURSE OBJECTIVES

These course objectives will enable the students

1. To understand modern product development processes.
2. To understand and explain the concept of Industrial design and robust design concepts.
3. To understand the concept of Design for manufacture and assembly.
4. To understand the legal factors, social issues, engineering ethics related to product design
5. To prepare primary designs taking into consideration ergonomics and aesthetic aspects of the product.
6. To understand the concept of Concurrent engineering, rapid prototyping.

COURSE OUTCOMES

At the end of the course, the students will

1. Understanding modern product development processes.
2. Understanding and explain the concept of Industrial design and robust design concepts.
3. Understanding the concept of Design for manufacture and assembly.
4. Understanding the legal factors, social issues, engineering ethics related to product design
5. Preparing primary designs taking into consideration ergonomics and aesthetic aspects of the product.
6. Understanding the concept of Concurrent engineering, rapid prototyping.

UNIT I
INTRODUCTION

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements - Organization process management and improvement

UNIT II
CONCEPT GENERATION, SELECTION AND TESTING

Plan and establish product specifications. Task - Structured approaches - clarification – search externally and internally-Explore systematically - reflect on the solutions and processes – concept

selection - methodology - benefits. Implications - Product change - variety – component standardization - product performance - manufacturability – Concept Testing Methodologies.

UNIT III
PRODUCT ARCHITECTURE
Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems - architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV
INDUSTRIAL DESIGN
Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically - Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinementmanagement of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.

UNIT V
DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT
Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

TEXT BOOK:

1. "Product Design and Development", Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.2012

REFERENCE BOOKS:

1. "Concurrent Engineering/Integrated Product Development". Kenneth Crow, DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book 11

2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin,Homewood, 1992
3. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk,NY,1991, ISBN 0-202-41639-5

POWDER METALLURGY
(Effective from the academic year 2018-2019 onwards)

CODE:18RME321

COURSE OBJECTIVES
These course objectives will enable the students

1. To introduce the field of Powder Metallurgy and engineering applications; from historical background to contemporary advanced applications
2. To introduce and explain basic methodologies and techniques for metal powder production
3. To describe important powder characteristics, and related characterization techniques.
4. To explain basic shaping and consolidation technologies applied in powder metallurgy and preparation necessary powder mixtures necessary to them.
5. To explain sintering phenomena and related sintering technologies
6. To provide information on secondary operations applied in powder metallurgy and introduce some of contemporary powder metallurgy engineering applications.

COURSE OUTCOMES
At the end of the course, the students will

1. Introducing the field of Powder Metallurgy and engineering applications; from historical background to contemporary advanced applications
2. Introduce and explain basic methodologies and techniques for metal powder production
3. Describing important powder characteristics, and related characterization techniques.
4. Explaining basic shaping and consolidation technologies applied in powder metallurgy and preparation necessary powder mixtures necessary to them.
5. Explaining sintering phenomena and related sintering technologies
6. Providing information on secondary operations applied in powder metallurgy and introduce some of contemporary powder metallurgy engineering applications.

UNIT I
INTRODUCTION

scope of powder metallurgy, characterization of metal powders, physical properties-particle size and shape determination, technological properties-apparent density, tap density, green density, sintered density, flow rate etc.

UNIT II
POWDER MANUFACTURING
reduction, electrolysis, and atomization processes. Compaction and consolidation: Diecompaction and other advanced consolidation techniques like hot pressing (HP), hot iso-static pressing (HIP), spark plasma sintering (SPS) etc.

UNIT III
SINTERING
solid and liquid state sintering, sintering mechanisms. Sintering furnaces and sintering atmospheres. Sintering theory and the influence of different processing conditions, wetting and surface diffusion.

UNIT IV
POWDER METALLURGY PRODUCTS
Bearing, filters, friction parts, hard metals, refractory metals, contact materials, magnetic materials, structural parts, and dispersion strengthened materials.

TEXT BOOKS:

1. R.M.German, “Powder Metallurgy Science”, 2nd edition- Metal Powder Industries Federation, Princeton, NewJersey, 1994.
2. M.N. Rahaman, “Ceramic Processing and Sintering”, Marcel Dekker, New York, 1995.
3. G. Goetzel, “Treatise on Powder Metallurgy”, Interscience Publishers, New York, 1952.

REFERENCE BOOKS:

1. G.S. Upadhyaya, “Powder Metallurgy Technology”, Cambridge International Science Publishing, 1997.
2. A.K. Sinha, “Powder Metallurgy”, DhanpatRai Publication, 2006.

SMART MANUFACTURING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME322

COURSE OBJECTIVES
These course objectives will enable the students

1. To learn the components of smart manufacturing system
2. To understand the automated production lines in smart manufacturing system
3. To study the efficiency and effectiveness of smart manufacturing system
4. To understand the existing IoT and Cloud architectures
5. To design an IoT system with cloud infrastructure
6. To implement a prototype of the IoT/cloud system design

COURSE OUTCOMES
At the end of the course, the students will

1. Learn the components of smart manufacturing system
2. Understand the automated production lines in smart manufacturing system
3. Study the efficiency and effectiveness of smart manufacturing system
4. Understand the existing IoT and Cloud architectures
5. Design an IoT system with cloud infrastructure
6. Implement a prototype of the IoT/cloud system design

UNIT I
INTRODUCTION

Overview, and components of manufacturing systems, Design, operation, and control of manufacturing systems.

UNIT II
TYPES OF MANUFACTURING SYSTEMS
Single station cells, manual assembly lines, automated production lines, transfer lines, analysis automated assembly systems.

UNIT III
PERFORMANCE OF MANUFACTURING SYSTEM
Productivity, quality, reliability, agility, responsiveness, sustainability, utilization & availability, flexibility, reconfigurability, resiliency, efficiency and effectiveness of manufacturing system, metrics and key performance indicators.

UNIT IV
GROUP TECHNOLOGY AND CELLULAR MANUFACTURING
Flexible manufacturing systems, changeable manufacturing systems, Just-In-Time and lean production, automation. Agile/demand driven manufacturing, Quick response manufacturing, world class manufacturing and holonic manufacturing systems.

UNIT V
COMPUTER INTEGRATED MANUFACTURING
Enterprise Integration (ISA-95 and other standards), Digital Manufacturing and smart manufacturing systems.

TEXTBOOKS:

1. M. P. Groover, “Automation, Production systems and Computer Integrated Manufacturing”. 3rd edition, Pearson Education, 2015. ISBN: 978-9332549814.
2. N. Singh, “Systems Approach to Computer Integrated Design and Manufacturing”, 1st edition, Wiley India, 2011. ISBN: 978-8126530410.

REFERENCE BOOKS:

1. G. Chryssolouris, “Manufacturing Systems: Theory and Practice”. 2nd edition, Springer, 2006. ISBN: 978-1441920676.
2. W. J. Hopp, M. L. Spearman, “Factory Physics”, 3rd edition, Waveland Press, 2011.
3. E. Turban, L. Volonino, “Information Technology for Management: Transforming Organizations in the Digital Economy”, 7th edition, Wiley India Private Limited, 2010. ISBN: 978-8126526390.

4. R. Askin and C. Standridge, "Modeling and Analysis of Manufacturing Systems", 1st edition, John Wiley, 1992. ISBN: 978-0-471-51418-3.

CRYOGENIC ENGINEERING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME323

COURSE OBJECTIVES
These course objectives will enable the students

1. To provide the knowledge of evolution of low temperature science
2. To provide knowledge on the properties of materials at low temperature
3. To familiarize with various gas liquefaction and refrigeration systems
4. To provide design aspects of cryogenic storage and transfer lines
5. To Understand the cryogenic metallurgy and its medical applications
6. To Understand the cryogenic insulation and its applications

COURSE OUTCOMES
At the end of the course, the students will

1. Learn the knowledge of evolution of low temperature science
2. Provide the knowledge on the properties of materials at low temperature
3. Familiarize with various gas liquefaction and refrigeration systems
4. Provide design aspects of cryogenic storage and transfer lines
5. Understand the cryogenic metallurgy and its medical applications
6. Understand the cryogenic insulation and its applications

UNIT I
CRYOGENIC SYSTEMS

Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect.

UNIT II
LIQUEFACTION CYCLES
Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Collins Cycle, Dual Pressure Cycle, Helium Regrigerated Hydrogen Liquefaction Systems. Critical components in Liquefaction Systems, Introduction to air separation.

UNIT III
CRYOGENIC REFRIGERATORS
J.T. Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators ; Storage and transfer of Cryogenic liquids, Design of storage vessels.

UNIT IV
CRYOGENIC INSULATION
Multi-layer insulation, Vacuum insulation etc. Applications: Applications of cryogenic in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications.

TEXT BOOKS:

1. K. D.Timmerhaus and T.M. Flynn, “Cryogenic Process Engineering”, Plenum Press, 1989.
2. R. F. Barron, “Cryogenic Systems”, McGraw Hill, 1985.
3. R.B.Scott, “Cryogenic Engineering”, Van Nostrand and Co., 1962.

REFERENCE BOOKS:

1. H. Weinstock, “Cryogenic Technology”, 1969.
2. 2.R.W. Vance, “Cryogenic Technology”, John Wiley & Sons, Inc., New York, London.

APPLIED ELASTICITY & PLASTICITY
(Effective from the academic year 2018-2019 onwards)

CODE:18RME324

COURSE OBJECTIVES
These course objectives will enable the students

1. To explain the stress, strain, torsion and bending properties.
2. To Calculate and determine the stress, strain and deflection of solid body that subjected to external and internal load.
3. To understand different methods that used to analyse stress and strain in solid body.
4. To apply various principles to solve problems in a practical situation and compare its solution with that obtained by solid mechanics approach.
5. To examine different yield criteria in diverse failure situations.
6. To explain the theory of plasticity to manufacturing.

COURSE OUTCOMES
At the end of the course, the students will

1. Apply the concepts of stress, strain, torsion and bending and deflection of bar and beam in engineering field
2. Calculate and determine the stress, strain and deflection of solid body that subjected to external and internal load.
3. Enable to design the optimum dimension of the body in a variety of situations where specific properties are required.
4. Relates the basic theory of elasticity and plasticity with application of solid mechanics.
5. Provides an understanding how the stress-strain characteristics affect ultimate failure of materials.

6. Able to relate theory of plasticity to design tooling in manufacturing instead of using 'thumb rule'.

UNIT I
ANALYSIS OF STRESS
Introduction, Stress components at an arbitrary plane, Principal stresses, Stress invariants, Construction of Mohr's circle, Differential equation of equilibrium, Plane stress problem, Boundary conditions; Analysis of Strain: Introduction, Principal strains, Strain deviator and its invariants, Plane strain problem, Compatibility conditions.

UNIT II
STRESS-STRAIN RELATIONS
Introduction, Generalized Hooke's law, Stress-strain relations for isotropic and orthotropic materials, Displacement equations of equilibrium; Two Dimensional Problems inElasticity.

UNIT III
STRESS FUNCTION
Solution by polynomials, Saint-Venant's Principle, Concentrated force acting on a beam, Effect of circular holes on stress distribution of a plate, Thick-walled cylinder Subjected to internal and external pressure, Rotating disks of uniform thickness.

UNIT IV
TORSION
Introduction, Torsion of general prismatic bars, Torsion of circular and elliptical bars, Torsion of equilateral triangular bars, Membrane analogy, Torsion of a thin-walled tubes, Torsion of a thin-walled multiple-cell closed section, Torsion or rolled sections.

UNIT V
INTRODUCTION TO PLASTICITY
Introduction, Nonlinear stress-strain behavior, Theories of failure, Criterion of yielding, Strain hardening postulates, Rule of plastic flow.

TEXT BOOKS:

1. "Theory of Elasticity" – S P Timoshenko and J N Goodier, McGraw Hill.
2. "Computational Elasticity" – M Ameen, Narosa Publishing House.

REFERENCE BOOKS:

1. "Advanced Mechanics of Solids" – L S Srinath, Tata McGraw-Hill
2. "Theory of Plasticity" – J Chakrabarty, Elsevier Butterworth-Heinemann
3. Advanced Mechanics of Materials – A P Boresi and R J Schmidt, John Wiley & Sons, Inc.

NON-TRADITIONAL PARAMETER IN DESIGN
(Effective from the academic year 2018-2019 onwards)

CODE:18RME325

COURSE OBJECTIVES

1. To learn about fatigue and its controlling factors.
2. To learn about creep and combined stresses.
3. To study about thermo-elasticity concept.
4. To study about thermal stress and deflection in beams.
5. To study about estimation of the strain energy in mechanical elements.
6. To study about buckling and bending phenomenon in columns, struts and beams.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Demonstrate understanding of various design considerations.
2. Illustrate basic principles of design.
3. Design machine elements for static as well as dynamic loading.
4. Design machine elements on the basis of strength/ rigidity concepts.
5. Use design data books in designing various components.
6. Acquire skill in preparing production drawings pertaining to various designs.

UNIT I
DESIGN FOR FATIGUE

Fatigue under normal conditions, controlling factors in fatigue, Design for fatigue.

UNIT II

FRACTURE THEORIES OF STRENGTH AND WORKING STRESS

Temperature and creep stress strain properties, creep in tensor, creep in bending, members, Subjected to creep and combined stresses, Basic modes fracture.

UNIT III

FORMULATION AND SOLUTION OF TWO DIMENSIONAL THERMO ELASTIC PROBLEMS

Basic problems in Thermo-elasticity, circular disc and cylinder with radial temperature distribution.

UNIT IV

THERMAL STRESS AND DEFLECTION IN BEAMS

Thermal stress and deflection in beams- introduction-problems.

TEXT BOOKS:

1. J.M. Lessels. “Resistance of Materials” - (Ch.6, 7, 8 and 11).
2. J.Marie, “Mechanical Behavior of Engineering Materials” - (Chap.7 and 8).
3. Boley and Weiner, “Theory of thermal stresses” - John Wiley. (Chap. 4, 8, 9 and 10).

VACUUM TECHNOLOGY
(Effective from the academic year 2018-2019 onwards)

CODE:18RME326

COURSE OBJECTIVES

1. Understand vacuum system operation.
2. Understand basic vacuum components and their functions.
3. Select and size components for typical applications.
4. Carry out systematic troubleshooting of vacuum control systems.
5. To study about leak detection and detectors.
6. To study about the application of vacuum technology.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Apply basic vacuum principles such as the behavior of gas and behavior of a vacuum system while evaluating a pump down.
2. Consider basic mechanisms and characteristics of vacuum system components such as pumps, valves and gauges while troubleshooting.
3. Perform basic operations of a vacuum system such as measuring pressure correctly, venting a vacuum system, a rough pump down.
4. Perform basic operations of a high vacuum pump down with correct valving sequence.
5. Perform simple maintenance of vacuum systems including installation or replacement of various pipes, fittings, valves, gauges, and simple pumps.
6. Perform vacuum trouble-shooting including leak isolation and detection.

UNIT I
BASIC THEORY
Gas kinetic theory, pressure, conductance, gas flow regimes, vapour pressure, pumping speed, throughput. Gas surface interactions: physisorption, chemi-sorption, condensation.

UNIT II
VACUUM PUMPS
Mechanical, diffusion, molecular drag, turbo molecular, cryopumps, ion pumps - general working principles, operating regimes.

UNIT III
VACUUM INSTRUMENTATION
Vacuum gauges, gas regulators, flow meters, residual gas analyzers, interpretation of data.

UNIT IV
DESIGN CONCEPTS
Materials, chambers, components, joins, seals, valves. Overall system design and integration. ; Problem Solving: Leak detection and detectors, gas signatures.

UNIT V
VACUUM APPLICATIONS
Freeze drying, packaging, vacuum coating, microelectronics, particle accelerators, distillation, metallurgical processes, television and X-ray tubes, cryogenic insulation, space simulation.

TEXT BOOKS:

1. V.V. Rao, T.B. Ghosh, K.L. Chopra, “Vacuum Science and Technology”, Allied Publishers Ltd., New Delhi(1998).
2. A. Roth, “Vacuum Technology”, North Holland Publishing Company, Amsterdam (1976).

REFERENCE BOOKS:

1. M. H. Hablanian, M. H. Hablanian, H. H. Hablanian, “High-vacuum Technology: A Practical Guide”, SecondEdition, Crc Press, 1997.
2. A.D. Tripathi A. Gupta Ac, “Ultra High Vacuum Techniques”, Allied Publishers Private Limited, 2002.

VIBRATION ANALYSIS & DIAGNOSTICS
(Effective from the academic year 2018-2019 onwards)

CODE:18RME327

COURSE OBJECTIVES

1. To understand the Fundamentals of Vibration and its practicalapplications.
2. To understand the working principle and operations of various vibrations Measuringinstruments.
3. To understand the importance of vibrationisolation.
4. To understand the various Vibration controlstrategies.
5. To equip them with skills to solve mathematically a multi-degree freedom system and continuoussystem.
6. To give exposure to the various experimental methods used for vibrationanalysis.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Develop mathematical model to represent dynamic system.
2. Estimate natural frequency of mechanical element / system.
3. Analyze vibratory response of mechanical element / system.
4. Estimate parameters of vibration isolation system.
5. Control the vibrations to the acceptable level using basic vibration principles.
6. Handle the vibration measuring instruments.

UNIT I

FORCED VIBRATION SYSTEM

Forced vibration with non harmonic and transient excitation of single degree freedom systems, Fourier analysis, Response to arbitrary loading (Duhamel's Integral), Impulse response, Mechanical shock, Parametric Excitation.

UNIT II

MULTI-DEGREE FREEDOM SYSTEMS

Two degree Freedom System, Multi-degree Freedom systems, modal analysis, Matrix iteration Method, Transfer matrix Method, Myklestadt-Prohl Method, Rayleigh's minimum principle, Stodola's Method, Hoizer's Method.

UNIT III

VIBRATIONS OF CONTINUOUS SYSTEMS

Vibrations of Continuous systems governed by wave equation and Euler Bernoulli equation, strings, membranes, rods, beams.

UNIT IV

VIBRATION ANALYSIS AND VIBRATION MONITORING

Experimental Methods in Vibration Analysis, industrial applications – rotors and other systems, vibration standards, vibration monitoring.

TEXT BOOKS:

1. P. Srinivasan, "Mechanical Vibration analysis" – 2nd Ed., TMH.1995
2. J.G. Rao &K.Gupta, "Introductory course on Theory and Practice of Mechanical Vibrations", – New Age Publication, 1995.

REFERENCE BOOKS:

1. L. Meirovitch, "Elements of Vibration Analysis", Tata McGraw Hill, Second edition, 2007.
2. W. T. Thomson, "Theory of Vibration with Applications", CBS Publ., 1990.

DESIGN OF MATERIAL HANDLING EQUIPMENT
(Effective from the academic year 2018-2019 onwards)

CODE:18RME328

COURSE OBJECTIVES

1. To provide students with the basic concepts related to the interactions between the production system parameters and their impact on materials handling systems design.
2. To provide students with methods for the generation of plant layouts.
3. To provide students with information on materials handling systems design for various aspects of the manufacturing and service industry.
4. To study about the design of cranes and structural components.
5. To study about the design of belt conveyors.
6. To study about design of bucket and swing tray elevators.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Describe and determine the effect of product, process, and schedule design parameters on plant layout and materials handling systems design.
2. Identify the characteristics of product and process layouts and their needs in terms of materials handling.
3. Develop and analyze plant layouts using manual and computer aided software methodologies.
4. Identify and select various types of material handling equipment.
5. Design material handling systems for a variety of scenarios pertaining to manufacturing and service industry.
6. Apply modern trends in the design of material handling devices.

UNIT I

INTRODUCTION

Development of material handling technology, design objectives, salient features of design, classification and characteristics of materials, types of industrial transport, classification and working principles of materials handling devices.

UNIT II

DESIGN OF CRANES AND STRUCTURAL COMPONENTS

Design of structural components, i.e. trolley, main girder, auxiliary truss, platform truss, end carriage and mechanical components i.e. wire rope, drum, pulley system, crane hook, brakes and drives of electric overhead traveling crane, stability and luffing motion of jib crane, conveyors, layout.

UNIT III

DESIGN OF BELT CONVEYORS

Design of components of belt conveyors, capacity and power requirement of screw conveyors, design of apron, gravity, roller and vibratory conveyors, hydraulic conveyors, layout, industrial installation, elevators,

UNIT IV

DESIGN OF BUCKET AND SWING TRAY ELEVATORS

Design of bucket and swing tray elevators, steel mill cranes, working principles and operations of various types of stripper, charger, ladle and soaking pit cranes, modern trends in the design of material handling devices.

TEXT BOOKS:

1. N.Rudenko, “Material handling equipments”, MIR publishers, 2nd Ed.
2. T. K. Roy, “Mechanical handling of materials”, Asian Books, 2004.

REFERENCE BOOKS:

1. A. Spivakovsky, “Conveyors and related equipments” –MIR Publishers.
2. M.P. Alexandrov, “Materials handling equipment” –MIR Publishers.

INTELLIGENT INDUSTRIAL AUTOMATION AND ITS APPLICATION
(Effective from the academic year 2018-2019 onwards)

CODE:18RME329

COURSE OBJECTIVES

1. The main objectives of the industry automation system introduction is lesser influence of human factor to technological process;
2. Improved production reliability;
3. Increased production speed and quality;
4. Prevention of emergency situations;
5. Improved production control.
6. Automated process control system (APCS)

COURSE OUTCOMES

1. Student will understand about industry automation system introduction is lesser influence of human factor to technological process;
2. Student will understand about Improved production reliability
3. Increased production speed and quality;
4. Prevention of emergency situations;
5. Improved production control.
6. Student will understand about Automated process control system (APCS)

UNIT I

INTRODUCTION TO INDUSTRIAL AUTOMATION

Intelligent Systems, Hydraulic Actuators for Industrial Automation, Principles and Strategies of Automation, BasicElements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines. (SLE: Analysis of Transfer Lines)

UNIT II

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES

Overview of Material Handling Systems,Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. (SLE: Material Identification Methods)

UNIT III

AUTOMATED MANUFACTURING SYSTEMS

Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools,Inspection Principles and Practices, Inspection Technologies. (SLE: Usage of SPC tools using excel or Minitab).

UNIT IV

CONTROL TECHNOLOGIES IN AUTOMATION

Industrial Control Systems, Process Industries VersusDiscrete-Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms. Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADASystems& RTU. Distributed Control System: Functional Requirements, Configurations & some popularDistributed Control Systems. (SLE: Display Systems in Process Control Environment.)

UNIT V

AUTOMATION AND INDUSTRIAL CONTROL APPLICATIONS

Electric Drives, Sensors and Vision used for automation, Trajectory planning, Automation Algorithm, Programming and flow control for automation. Modeling and Simulation for Plant Automation: Introduction, need for system Modeling,Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement, Thermal, Water Treatment & Steel Plants. (SLE: Cases Studies minimum one for Cement, Thermal, Water Treatment & Steel Plants applications).

TEXT BOOK:

1. Automation, "Production Systems and Computer Integrated Manufacturing",M.P.Groover, Pearson Education.5th edition, 2009.

REFERENCE BOOKS:

1. "Computer Based Industrial Control"- Krishna Kant, EEE-PHI,2nd edition,2010
2. "An Introduction to Automated Process Planning Systems"- Tiess Chiu Chang & Richard A. Wysk.
3. "Performance Modeling of Automated Manufacturing Systems",-Viswanandham, PHI, 1st edition, 2009.
4. G.S. Hegde, "A Textbook on Industrial Robotics", University Science Press, Second Edition 2008, ISBN 978-81-318-051803

SOFT COMPUTING FOR INTELLIGENT MANUFACTURING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME330

COURSE OBJECTIVES

1. To introducing the fundamental theory and concepts of computational intelligence methods.
2. In particular neural networks,
3. To understand the Fuzzy systems
4. Genetic algorithms and their applications.
5. To understand the area of machine intelligence,
6. vision sensors condition monitoring of manufacturing systems.

COURSE OUTCOMES

1. To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications.
2. To understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems.
3. To understand the fuzzy logic control and other machine intelligence applications of fuzzy logic.
4. To understand the basics of an evolutionary computing paradigm known as genetic algorithms and its application to engineering optimization problems.
5. To understand the Genetic algorithms and their applications in the area of machine intelligence
6. To understand the vision sensors Condition monitoring of manufacturing systems

UNIT I
INTRODUCTION

Foundations: Stochastic processes; Principal component analysis; Learning theory; Generalization and regularization;

UNIT II
FUZZY LOGIC
Fuzzy set theory, fuzzy rule and fuzzy reasoning, fuzzy relation, fuzzy inference system, fuzzy modeling, Sugneo type fuzzy system; Supervised learning network:

UNIT III
BACK PROPAGATION LEARNING ALGORITHM
Back propagation learning algorithm, Back propagation multi layered perceptron, method for speeding of back propagation, Radial basis function network, Summary; Unsupervised learning: Competititve learning network, Kohenberg self organisng network, LVQ, Hebbian learning, Hopefield network, ART Network;

UNIT IV
ROLE OF SENSORS IN MANUFACTURING AUTOMATION
Operation principles of different sensors - electrical, optical, acoustic, pneumatic, magnetic, electrooptical and vision sensors Condition monitoring of manufacturing systems - principles - sensors for monitoring force, vision, vibration, acoustic, temperature, current and noise, selection of sensors and monitoring techniques ;

UNIT V
APPLICATION OF SOFT COMPUTING TO FAULT DIAGNOSIS AND FAILURE ANALYSIS
Online Tool wear monitoring in turning, drilling, milling operation, Online Dimensional deviation detection in turning, Online roughness evaluation of EDM, ECM process, online measurement of hole straightness in a LBM.

TEXT BOOK:

1. A. Kaufmann and M. M. Gupta, “Introduction to fuzzy arithmetic theory and application”, International Thomson computer press, 1st edition (1991)

REFERENCE BOOKS:

1. S Haykin, “Neural Network”, PHI, 2004
2. G. Onwubolu, E. Butterworth, “Mechatronics Principle and Application”, Heinnmen Pub.

GAS TURBINES AND JET PROPULSION
(Effective from the academic year 2018-2019 onwards)

CODE:16RME331

COURSE OBJECTIVES

1. Students will establish understanding of propulsion systems in aircraft that are essential to graduate engineers.
2. Students are intended to work in aircraft system/component manufacturing/maintenance environments.
3. Students should be able to describe and appreciate the key aeronautical engineering features of the context in which the relevant industry operates.
4. Jet Propulsion, Gas Turbine, Engine Types, Performance, Turbojet and Turbofan Engines, Designs of Compressor, Combustor, and Turbines.
5. Centrifugal fans blowers and compressors.
6. Students will understand the working of various parts of gas turbines.

COURSE OUTCOMES

1. Students will gain skills in problem solving for aircraft propulsion systems, in particular gas turbine engines.
2. Students will gain ability to carry out a cyclic analysis of a gas turbine engine, including turbofan.
3. Students will be able to determine the applicability of a given propeller system for a given aircraft.
4. Students will understand the working of various parts of gas turbines.
5. Students will understand important factors affecting combustion chamber design
6. Students will understand Gas turbine rotors and stresses

UNIT I

INTRODUCTION

Application, shaft power gas dynamics –Compressibility effect, steady one dimensional compressible flow of a perfect gas in a duct, isentropic flow in a constant area duct with friction, normal shock waves, oblique shock wave, isentropic two dimensional, supersonic expansion and compression.

UNIT II

CENTRIFUGAL FANS BLOWERS AND COMPRESSORS

Principle of operations, work done and pressure rise, slip factor, diffusers, compressibility effects, non dimensional qualities for plotting compressor characteristics. Bray ton cycle, regeneration and reheating cycle analysis ; Axial flow fans and compressors

UNIT III

DESIGN AND PERFORMANCE

Elementary theory, degree of reaction, three dimensional flow, simple design methods, blade design, calculation of stage performance, overall performance, and compressibility effects. Performance characteristics.

UNIT IV

COMBUSTION SYSTEM

Form of combustion, important factors affecting combustion chamber design, combustion processes, combustion chamber performance, practical problem. ; Axial flow turbines: elementary theory, vortex theory, choice of blade profile, pitch and chord ; estimation of stage performance, he cooled turbine.

UNIT V

PREDICTION OF PERFORMANCE OF SIMPLE GAS TURBINES

Component characteristic, off design shaft gas turbine, equilibrium running gas generators, off design o free turbine and jet engine, methods of displacing the equilibrium, running line, incorporation of variable pressure losses, methods of improving part load performance, matching procedure for twin spool engines, behavior of gas turbine. Gas turbine rotors and stresses.

TEXT BOOKS:

1. J.E Lee, “Theory and design of stream and gas turbine”.
2. Cohen & Rogers, “Gas Turbines”

ALTERNATIVE FUELS FOR IC ENGINES
(Effective from the academic year 2018-2019 onwards)

CODE:18RME332

COURSE OBJECTIVES

1. Study on the fuel system interaction with alternative fuels. Fuels considered should include both proposed fuels as neat fuels and as various types of blends. Questions include
2. Filtering of neat/blends fuels
3. Injection pump operation/control
4. Injector operation/control
5. Fuel solution stability and chemical stability within injection systems including high pressures, temperatures and return flow.
6. Fuel deposits formation in tank, filters, pump and injectors. This also includes deposits influence on spray/combustion.

COURSE OUTCOMES

1. Student will understand about Filtering of neat/blends fuels
2. Student will understand about Injection pump operation/control
3. Student will understand about Injector operation/control.
4. Study on the transport system implications from types of alternative fuels.
5. This includes the powertrain as well as the vehicle configuration.
6. Simulation capability for the systems at various levels to be considered.

UNIT I
ALTERNATE FUELS

Estimation of petroleum reserve - Need for alternate fuel - Availability and properties of alternate fuels – general use of alcohols - LPG - Hydrogen - Ammonia, CNG and LNG - Vegetable oils and Biogas – Solar – Merits and demerits of various alternate fuels ;

UNIT II
PROPERTIES OF ALCOHOLS AND CNG
Properties, alcohols and gasoline blends, performance in SI engine. Methanol and gasoline blends - Combustion characteristics in engines - emission characteristics - Engine modifications ; Availability of CNG, properties, modification required to use in engines - performance and emission characteristics of CNG using LPG in SI & CI engines.

UNIT III
ENGINE MODIFICATION AND PERFORMANCE
Performance and emission for LPG – Hydrogen – Storage and handling, performance and safety aspects ; Various vegetable oils for engines – Single and dual fuel use – Engine modifications - SVO - Esterification - Performance in engines - Performance and emission characteristics ;

UNIT IV
LAYOUT OF AN ELECTRIC VEHICLE
Layout of an electric vehicle - Advantage and limitations - Specifications - System component.

UNIT V
VEHICLE SYSTEM
Electronic control system - High energy and power density batteries - Hybrid vehicle - Solar powered vehicles.

REFERENCE BOOKS:

1. M. Dayal, “Energy today & tomorrow”, I & B Horishr India, 1982.
2. Nagpal, “Power Plant Engineering”, Khanna Publishers, 1991.
3. “Alcohols and motor fuels progess in technology”, Series No.19, SAE Publication USA 1980 SAE PaperNos. 840367, 841156, 841333, 841334
4. “The properties and performance of modern alternate fuels” - SAE Paper No.841210. SAE Handbook

AIRCRAFT AND ROCKET PROPULSION
(Effective from the academic year 2018-2019 onwards)

CODE:18RME333

COURSE OBJECTIVES

1. Students will establish understanding about gas turbine engine,
2. Thermodynamics of propulsion system, working principles of gas turbine engine
3. Calculation of stage performance and overall performance
4. Limitations of hybrid rockets, Relative advantages of liquid rockets
5. Principles of multistage rocket,
6. Working principles of turbojet cycle

COURSE OUTCOMES

1. Student will understand about Engine performance parameters and Working principles of ideal ramjet cycle
2. Student will understand about working principles of gas turbine engine.
3. Student will understand about Rocket system and aerodynamics of rockets
4. Student will understand about Calculation of stage performance and overall performance
5. Student will understand about working principles of multistage rocket
6. Student will understand about Limitations of hybrid rockets, Relative advantages of liquid rockets

UNIT I
GAS TURBINE ENGINE
Introduction, Rocket system and aerodynamics of rockets, Fundamentals of gas turbine engines, Illustration of working principles of gas turbine engine.

UNIT II

PROPULSION SYSTEM AND OPERATING PRINCIPLE

Thermodynamics of propulsion system, Engine performance parameters, The ramjet cycle, Working principles of ideal ramjet cycle, The turbojet cycle, Working principles of turbojet cycle, Non-ideal turbojet cycle, Axial flow fans and compressors.

UNIT III

CALCULATION OF PERFORMANCE

Polytrophic efficiency of compression, Calculation of stage performance and overall performance, Working principles of turbofan cycle.

UNIT IV

ROCKET PERFORMANCE

Introduction and working principles of multistage rocket, Solid propellant rockets, Liquid propellant rockets ,Thrust control in liquid rockets Cooling in liquid rockets.

UNIT V

HYBRID ROCKETS

Limitations of hybrid rockets, Relative advantages of liquid rockets over solid rockets.

REFERENCE BOOKS:

1. G.C. Oates, “Aerothermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.
2. W.W. Bathie, “Fundamentals of Gas Turbine”s- John Wiley & Sons, 1984.
3. M.L. Mathur, and R.P. Sharma, “Gas Turbine Jet and Rocket Propulsion”, Standard Publishers and Distributors,Delhi, 1988.
4. P.G. Hill, “Mechanics and Thermodynamics of Propulsion”- Addison Wesley, 1970.
5. S.M. Yahya, “Fundamentals of Compressible Flow” - John Wiley, New York, 1982.
6. A.K. Mohanty, “Fluid Mechanics” - Prentice Hall, New Delhi, 2003.

ENERGY CONSERVATION AND MANAGEMENT
(Effective from the academic year 2018-2019 onwards)

CODE:18RME334

COURSE OBJECTIVES

1. To bring out knowledge on Energy Conservation
2. To impart knowledge in the domain of energy conservation.
3. To facilitate a clear conceptual understanding of technical aspects of energy conservation
4. To bring out knowledge on various Energy Sources.
5. To inculcate knowledge and skills about assessing the energy efficiency
6. To facilitate a clear conceptual understanding of commercial aspects of energy conservation

COURSE OUTCOMES

On completion of this course, the students will be able to exhibit

1. Understand the significance and procedure for energy conservation
2. Understand causes and remedies for global energy issues.
3. Opportunity to know the conceptual knowledge of the technology associated with energy conservation
4. Capability to integrate various options of sources from environment regarding energy conservation
5. Knowledge of existing and upcoming industrial utility and energy management theory
6. Skill to identify and learn fields problem in a multi-disciplinary frame

UNIT I

ENERGY SOURCES

Classification and characterization of fuels (fossil and bio-fuel), conversion and utilization, environmental and economic issues, optimum use of energy resources,

UNIT II

BOILERS, ICE and GAS TURBINES

Thermodynamic cycles, Principles of thermal energy conversion in boilers, internal combustion engines and gas turbines, cogeneration and combined cycle power generation.

UNIT III

ENERGY MANAGEMENT

Fuel cells and MHD technology, solar, wind and nuclear power, utilization of industrial heat, Energy management in industry.

UNIT IV

POLLUTION CONTROL

Environmental and economic evaluation advanced pollution control technology.

TEXT BOOKS:

1. R. Gold Stick and A. Thumann, “Principles of Waste Heat Recovery”, PHI, 1986.
2. D. Y. Goswami, F. Kreith, “Energy Conversion”- CRC Press, 2007
3. V. Kadambi, and M. Prasad, “Introduction to energy conversion turbo machinery: Energy conversion cycle”-Wiley Eastern, New Delhi, 1974,

SUPERCONDUCTING MATERIALS, MAGNETS AND DEVICES
(Effective from the academic year 2018-2019 onwards)

CODE:18RME335

COURSE OBJECTIVES

1. To provide basic knowledge of superconductivity
2. To observe two of the fundamental properties of superconductors.
3. Describe the main features of a superconductor
4. To deliver emphasis is made on qualitative description, providing basic science background
5. To learn Electricity and magnetism are fundamentally related.
6. To explain how electricity and magnetism work together in electric motors and generators

COURSE OUTCOMES

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

1. Phenomenological describe the phenomenon of super conduction
2. Explain how superconductors behave in magnetic fields
3. Distinguish between perfect conduction and perfect diamagnetism
4. Explain how observation of a persistent current can be used to estimate an upper limit on the resistivity of a superconductor, and perform calculations related to such estimates
5. Explain why the magnetic flux through a superconducting circuit remains constant, and describe applications of this effect
6. Describe some applications of superconductors in Power Engineering

UNIT I
SUPERCONDUCTORS

Thermal, electrical and magnetic properties of materials at low temperature, Basic properties of superconductors; Type I and Type II superconductors; Tunneling phenomena. Critical current densities and critical magnetic fields of type II superconductors

UNIT II
TECHNIQUES OF PREPARATION OF SUPERCONDUCTING MATERIALS
Magneto-thermal instabilities in type II superconductors; Concept of flux pinning mechanisms. Techniques of preparation of superconducting materials of type NbTi, Nb3Sn, V3Ga and ceramic superconductors in the form of wires and tapes; Stabilization criteria.

UNIT III
SUPERCONDUCTING COIL DEVICES
Superconducting magnets, persistent current switches; Basic concepts of superconducting bearings, motors and energy storage devices. Superconducting thin film devices: negative resistance devices.

UNIT IV
WEAK LINK DEVICES
Weak link devices including SQUIDS and their applications; infrared detectors.

TEXT BOOK:

1. T.H.K Frederking, S.W.K Yuan, “Cryogenic-Low Temperature Engineering & Applied Sciences”, Yutopian Enterprises (December 15, 2005).

REFERENCE BOOKS:

1. C. David, SG David, “Handbook of Superconducting Materials” Volume 2, Taylor & Francis Group 2005.
2. Asner, M. Fred, “High Field Superconducting Magnets”, Oxford University Press, USA.

AIR SEPARATION AND INDUSTRIAL GASES
(Effective from the academic year 2018-2019 onwards)

CODE:18RME336

COURSE OBJECTIVES

1. To introduce the working principles of three basic methods to achieve low temperature
2. To define fundamentals of mass transfer and analyse mass transfer in two-phase fluid systems
3. To understand properties of cryogenic liquids and solids, refrigeration technologies
4. To Comprehend gas separation and gas purification system
5. To discuss air liquefaction process, industrial gas separation
6. To understand the varying clinical picture created by the gases, based on their physical properties and toxicity

COURSE OUTCOMES

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

1. Possess basic knowledge of cryogenics.
2. Understand the applications of classical thermodynamics to different cryogenic technologies, gas separation and purification system.
3. Understand the measurement equipment and basic experimental skills, in particular of cryogenic heat transfer.
4. Design experiences for practical cryogenic systems requiring significant consideration of thermodynamics cycles.

5. Knowledge of various chemical engineering separation processes
6. Ability to Select appropriate separation technique for intended problem

UNIT I
PRINCIPLES OF DIFFUSION AND MASS TRANSFER
Fick's Law of Diffusion, Molecular diffusion in fluids, mass transfer coefficients in laminar and turbulent flow; mass, heat and momentum transfer analogies.

UNIT II
INTRODUCTION TO CRYOGENIC GAS SEPARATION AND PURIFICATION SYSTEMS
Principles of absorption, adsorption, condensation and rectification. Adsorption equilibria; types of adsorbant; adsorption/desorption cycles; PSA, TSA; steady state and dynamic adsorption; concept of break point and mass transfer zone; design of fixed bed adsorption system for gas separation and purification.

UNIT III
PHASE EQUILIBRIA AND PHASE RULE
equilibrium stage operation; X-Y, T-X,Y and H-X,Y diagrams and their use; design of rectification columns; different tray assemblies; types of column assemblies for cryogenic rectification;

UNIT IV
GAS SEPARATION
Gas separation using membranes. Linde single column and double column for air separation. Production of argon and rare gases; Air separation processes for different product mixtures. Processes for production of CO2 , N2O and C2H2, Helium and Hydrogen.

TEXT BOOKS:

1. R. E. Treybal, “Mass Transfer Operations”, Mc Graw-hill Education(Asia), 2003.
2. K.D.Timmerhaus and T.M.Flynn, “Cryogenic Process Engineering”, Plenum Press, 1989.

REFERENCE BOOKS:

1. R.F. Barron, “Cryogenic Systems”, McGraw Hill, 1985.

FUEL CELL TECHNOLOGY
(Effective from the academic year 2018-2019 onwards)

CODE:18RME337

COURSE OBJECTIVES

1. To know essential material for the hydrogen economy
2. To know details of fuel cell technology, in particular the opportunities for using hydrogen
3. To expose the students to the fundamental knowledge required in the development of fuel cell technology
4. To learn hydrogen production technologies with and without CO2 production as a by product
5. To Discuss the design philosophy and challenges to make this power plant economically feasible.
6. To learn how fuel cells are used for every day purposes: road, water and air transport vehicles, portable and stationary use.

COURSE OUTCOMES

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

1. Have the general knowledge of Fuel Cells as a promising technology in the context of clean power sustainability and alternative fuels for shipping.
2. Know different specific developments on Fuel Cells which are available today.
3. Identify different areas of fuel cell technology.
4. Have the knowledge of production of electricity cleanly and efficiently by using fuel cell
5. Defend the significance of fuel cell technology in the new global energy scenario.
6. Distinguish the expectances of hydrogen as a fuel and energy vector in the context of renewable energy.

UNIT I

INRODUCTION

Overview of current fuel cell technology. Operating principles, fundamental thermodynamics and electrochemistry.

UNIT II

TYPES OF FUEL CELLS AND APPLICATIONS

Proton exchange membrane fuel cells; components; performance; testing. Micro fuel cells. High temperature fuel cells. Modelling of transport phenomena in fuel cells.

UNIT III

HYDROGEN PRODUCTION AND STORAGE.

Fuel cell systems and ancillaries. Overview and status of various fuel cell technologies. Fundamentals: fuel cell thermodynamics; electrode kinetics; performance and efficiency; transport processes.

UNIT IV

FUELLING ISSUES

Proton Exchange Membrane Fuel Cells (PEMFCs). Solid Oxide Fuel Cells (SOFCs). Fuelling issues. Fuel cell systems and applications.

TEXT BOOK:

1. A.V. Da Rosa, 2005, “Fundamentals of Renewable Energy Processes”, Elsevier academic press.

REFERENCE BOOKS:

1. W. Vielstich, A. Lamm and H.A. Gastieger, 2003, “Handbook of Fuel Cells”, vol. 1-4, John Wiley.
2. G. Hogen ed. 2003, “Fuel Cell Technology Handbook”, crc press.

MICRO-MACHINING AND PRECISION ENGINEERING
(Effective from the academic year 2018-2019 onwards)

CODE:18RME338

COURSE OBJECTIVES

1. To Study of various micro machining processes
2. Explain about various materials and technologies
3. To introduce latest topics in Manufacturing like micro machining and smart materials
4. To impart knowledge in the increasing quality concepts of parts, accuracy requirement of machine tools
5. To inculcate specialized knowledge and skill in machining processes using the principles and methods of engineering analysis and design.
6. To explain the principles of manufacturing processes that contribute to the achievement of high precision

COURSE OUTCOMES

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

1. Aware of different techniques used in micro and nano manufacturing
2. Learn in-depth idea of the conventional techniques used in micro manufacturing
3. sIdentify/control the appropriate process parameters, and possible defects of manufacturing processes
4. Understand the principles of various micro and nano manufacturing methods.
5. Understand nano measuring and positioning systems.
6. Discover the principles applied to the production of modern high-precision machinery

UNIT I

INTRODUCTION TO MICROMACHINING TECHNOLOGIES

Introduction to micromachining technologies, bulk micromachining, LIGA, Surface Micromachining, Characterization of micro-machining, Tool making, Micromachinability of materials.

UNIT II

DIAMOND MICRO-MACHINING

Machining principles, diamond turning, diamond grinding, accuracy and dimensional control, molecular dynamics simulation of the atomic processes in micro-machining, principles of molecular dynamics, atomistic forces of chip formation and surface generation, future trends in ultrahigh speed machining.

UNIT III

MICROELECTRO DISCHARGE MACHINING

Principles of micro-EDM, micro-EDM by Die-sinking and WEDG, micro-WEDM, micro-WEDG, micro-ECM, Principles of micro-turning, micro-drilling and micro-milling, hybrid micro-machining method, on-line measurement by machine vision and integrated probe.

UNIT IV

ABRASIVE MICROMACHINING AND MICRO GRINDING

Abrasive micromachining mechanisms, micro-grinding mechanism, micro-machining rate, micro-machining cooling media. ; Laser micromachining: Principles of laser material removal, laser micro-drilling, laser micro-adjustment, laser surface structuring, laser micro-cutting.

UNIT V

MICRO-MACHINING BY FINISHING TECHNIQUES

Micro-lapping, micro-machining, magneto-abrasive micromachining and finishing (MAF), ELID Grinding. ; Measuring Techniques in micro-machining: stylus instruments, scanning tunneling microscopes, atomic force microscope, measurement of micromoles and slots using optical method, vibro-scanning method, elastic transmission method, computer aided measurement testing and diagnostics, surface integrity and other related measurements.

TEXT BOOKS:

1. J. M. Geough, “Micro-machining of Engineering Materials”, Edited by Marcel Dekker, 2002
2. R.W. Johnstone, M. Parameswaran, “An introduction to surface-micromachining”, Kluwer Academic Publishers, 2004

REFERENCE BOOKS:

1. N. P Mahalik. “Micro-manufacturing and nano-technology”, edited by, Springer Publication, 2006.
2. M. P. Groover, “Automation, Production Systems and Computer-Integrated Manufacturing”, 2003.