

Ph.D. COURSE WORK SYLLABUS

MECHANICAL ENGINEERING

RESEARCH METHODOLOGY

(Effective from the academic year 2015-2016onwards)

CODE: 15RME101

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 χ^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 2015-2016 onwards)

CODE: 15RME201

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.

UNIT III

INTEGER AND DYNAMIC PROGRAMMING

Introduction to integer programming – solution techniques - graphical method, the branch and bound technique, gomory'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", Addison Wesley Pub Co., 1989.
4. Marco Dorigo and Thomas Stutzle, "Ant Colony Optimization", Prentice Hall of India, 2005.
5. Maurice Clerc, "Particle Swarm Optimization", ISTE, 2007
6. Dimitri P Bertsekas, "Dynamic Programming: Deterministic and Stochastic Models", Prentice Hall, 1987.
7. Stephen G Nash and Ariela Sofer, "Linear and Nonlinear Programming", McGraw Hill College Div., 1995.
8. Fred Glover, Manuel Laguna and Fred Laguna, "Tabu Search", Kluwer Academic Publishers, 1997.

COMPUTATIONAL METHODS

(Effective from the academic year 2015-2016 onwards)

CODE:15RME202

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 2015-2016 onwards)

CODE:15RME203

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 from source 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 2015-2016 onwards)

CODE: 15RME204

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



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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 2015-2016 onwards)

CODE:15RME205

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 & Implicit Methods- Lanchzos, Reduced method for large size system equations.



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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 2015-2016 onwards)

CODE:15RME206

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 turbulence modeling.
4. To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.
5. To equip them with skills to solve convection and diffusion problems.
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 fluid dynamics.
2. Understand the importance of governing equations involved in CFD.
3. Formulate and solve problems in the field of fluid flow and heat transfer.
4. Solve the heat conduction problems using finite difference method.
5. Analyze and provide solutions for convection and diffusion problems.
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, $k - \epsilon$ 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”, Narosa Publishing House, New Delhi, 2003.
2. Ghoshdasgupta, 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 General Techniques”, 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 2015-2016 onwards)

CODE: 15RME301

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-



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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 theory- Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape in thin 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 2015-2016 onwards)

CODE: 15RME302

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



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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. Seropekelpkijian&Stevan R. Schmid- “Manufacturing process and Engineering materials” – 2003
2. “Micro sensors 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 2015-2016 onwards)

CODE:15RME303

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 2015-2016 onwards)

CODE: 15RME304

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



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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 & Maintenance 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. Houppis, "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 2015-2016 onwards)

CODE: 15RME305

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 its correlation

COURSE OUTCOMES

Students will learn

1. To understand applications of the heat transfer in various thermal applications
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 – $k-\epsilon$ 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 shear stress on bank of tubes - boiling – pool and flow boiling - heat exchanger – ϵ - 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.Cengel, “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 2015-2016 onwards)

CODE:15RME306

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



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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), Ballistic 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 2015-2016 onwards)

CODE:15RME307

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 (P), Ltd, New Delhi, 2002.
5. 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.



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LEAN MANUFACTURING

(Effective from the academic year 2015-2016 onwards)

CODE:15RME308

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.



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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 2015-2016 onwards)

CODE:15RME309

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 2015-2016onwards)

CODE:15RME310

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 2015-2016 onwards)

CODE:15RME311

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 of Clausius 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 C_p and C_v Clausius Clayperon equation, Joule – Thomson coefficient. Bridgeman tables for thermodynamic relations.

UNIT II

REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS



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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 – Dirac 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, McGraw – 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 Statistical Thermodynamics", Third Edition, John Wiley and Sons, 1991.
3. Sears, F.W. and Salinger G.I., "Thermodynamics, Kinetic Theory and Statistical Thermodynamics", Third Edition, Narosa Publishing House, New Delhi, 1993.
4. DeHof, R.T., "Thermodynamics in Materials", Science, McGraw – Hill Inc., 1993.
5. Rao, Y.V.C., "Postulational and Statistical Thermodynamics", Allied Publisher Limited, New Delhi, 1999.

ADVANCED INTERNAL COMBUSTION ENGINEERING (Effective from the academic year 2015-2016onwards)

CODE:15RME312

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 technological advances 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 performance and 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, NO_x, 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 2015-2016 onwards)

CODE:15RME313

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.

CODE:15RME314

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 isotropic materials.
2. Apply constitutive equations of composite materials and understand mechanical behavior 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 composite laminates; 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



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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 extrusion", 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 2015-2016 onwards)



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CODE:15RME315

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 , Babbitt alloy and Cu alloy.

UNIT III

RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT

Shell moulding, precision investment casting, CO₂ moulding, 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



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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", Tata McGraw Hill Publishers, 2003
7. Carry 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