MASTER OF TECHNOLOGY

Mechanical Engineering Department

Semester - I

Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
MA 5001	Optimization Methods	2	0	0	2
ME 5001	Power Generation I: Applied Thermodynamics	2	1	0	3
ME 5002	Advanced Manufacturing Techniques I	2	1	3	4
ME 5003	Design of Experiments	2	0	3	3
ME 500x	Elective I	3	0	0	3
	Total	**11**	**2**	**6**	**15**

∗**Only one subject offered under Elective I, in Academic Year 2016 − 17.**
ME 5004 Computational Methods in Engineering∗

MASTER OF TECHNOLOGY

Mechanical Engineering Department

Semester - I

I	Course Code	**MA 5001**			
II	Course Title	**Optimization Methods**			
III	Credit Structure	L	T	P	C
		2	0	0	2
IV	Prerequisites,if any	None			
V	Course Content	**Introduction to Optimization:** Introduction; Historical Development; Engineering Applications of Optimization; Statement of an Optimization Problem: Design Vector, Design Constraints, Constraint Surface, Objective Function, Objective Function Surfaces, Classification of Optimization Problems. **Linear Programming:** Introduction; Formulation of Linear Programming Problem (LPP); Solution of LPP: Some Important Defi- nitions, Graphical Method, Simplex Method, Big-M Method, Two- Phase Method, Types of LPP Solutions; Duality in Linear Programming; Importance of Dual Problems; Parametric Analysis, Transportation Problems: North West Corner Method, Least Cost Method, Vogel's Approximation Method, Modified Distribution (MODI) Method, Stepping Stone Method, Variation in Transportation Problems; Assignment Problem (Variation in Assignment Problem); Game Theory: Two Person Zero Sum Game, Game with Saddle Point, Game without Saddle Point, Solving Game by Different Method. **Introduction to Non-linear Programming:** Classical Optimization Techniques.			
VI	Textbooks/References	1.S. S. Rao, Engineering Optimization: Theory and Practice,John Wiley & Sons, 2009. 2.N. H. Shah, R. M. Gor and H. Soni, Operations Research,PHI Learning Pvt. Ltd., 2007. 3.S. D. Sharma, Operations Research, Kedar Nath Ram Nath & Co., 2005. 4.H. A. Taha, Operations Research: An Introduction, 7th Edition,MacMillan Publishing Co, 2003. 5.J. K. Sharma, Operation Research: Theory and Applications,McMillan Publishers India, 2008. 6.J. C. Pant, Introduction to Optimization Techniques (Operations Research), 6th Edition, Jain Brothers, New Delhi, 2005.			

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Mechanical Engineering Department

Semester - I

I	Course Code	**ME 5001**			
II	Course Title	**Power Generation I: Applied Thermodynamics**			
III	Credit Structure	L	T	P	C
		2	1	0	3
IV	Prerequisites,if any	None			
V	Course Content	Power generation systems - A Perspective, Basic concepts of Thermodynamics, Laws of thermodynamics, enthalpy, entropy, exergy, properties of pure substances, equation of state, Thermodynamic property relations. Vapor Power Cycles: Analyses of ideal & actual cycles Rankine cycle, Reheat cycle, regenerative cycles work ratio, heat rate, steam rate, thermal efficiency, heat balance, exergy analysis. Choice of feed-water heaters & their arrangements. Different practical losses in power plant cycles. Gas Power Cycles: Performance analyses of ideal & actual cycles Reheating, intercooling and regeneration. Introduction to Combined cycles, classification, binary vapor cycles, steam and gas turbine combined cycles. Fuels and combustion, Heats of Reaction and Formation, Sensible Enthalpy and Adiabatic Flame Temperature, First and second law analysis of Reacting systems, Chemical Kinetics.			
VI	Textbooks/ References	1. Eastop T. D., Applied Thermodynamics for Engineering Technologists, Pearson Education. 2. Moran M. J., and Shapiro H. N., Fundamentals of Engineering Thermodynamics, Wiley India. 3. Borgnakke and Sonntag, Fundamentals of Thermodynamics, Wiley India. 4. El-Wakil M. M., Power Plant Technology, McGraw Hill Education 5. Nag P. K., Power Plant Engineering, McGraw Hill Education			

MASTER OF TECHNOLOGY

Mechanical Engineering Department

Semester - I

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 5002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Advanced Manufacturing Techniques I</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite(s), if any</td><td colspan="4">Manufacturing Processes, Basic FEM and Statistics</td></tr>
<tr><td>V</td><td>Pedagogy</td><td colspan="4">Lectures, Seminars, Demonstrations, Hands On, Team Activities, Projects</td></tr>
<tr><td>VI</td><td>Course Content</td><td colspan="4">Materials Technology: This covers the technically important materials of interest to various manufacturing industries. Their specific manufacturing processes, properties and application fields, with particular emphasis on the infrastructure sectors related to aerospace, marine and automobile, would be explained. There would also be emphasis on manufacturing metrology, measuring and testing technology in component testing, data acquisition and processing, statistical analysis and design of experiments.
Machining Technology: This covers topics related to sustainable machining processes and process planning. In addition, machining process simulation and practical fundamentals with special emphasis on the finite element method will be discussed. Emphasis would be on the problems related to companies in the HVM sector (e.g. automotive, aerospace, defence, medical engineering) where at least 25% of the process time for components arises from machining.
Forming Technology: This provides an advanced knowledge of the forming manufacturing technology and the corresponding forming machines and processes. In addition, practical fundamentals with special emphasis on the finite element method will be discussed. Transformation of sheet metal to automotive/aerospace components would be focused.
Introduction to Additive Manufacturing and Digital Man- ufacturing. Laboratory Work: The laboratory work strictly incorporates experimental research. The laboratory work is performed in groups. Before the laboratory, the experiments need to be prepared. This means that each student has to possess an adequate knowledge of the theoretical foundations and practical implementation of the experiment.
Scientific Project Work: The Scientific Project includes a study-related homework in a team work format. Thereby, each student has to show his/her own preparation to evaluate their own performance. After the submission of the work, the results should be presented in the form of a presentation by each student.</td></tr>
<tr><td>VII</td><td>Textbooks/References</td><td colspan="4">1.Material and Processes in Manufacturing, Paul De Garmo, J.T. Black, and Ronald A. Kohser, Prentice Hall of India Private Limited, 2001.
2. Nontraditional Manufacturing Processes, Benedict. G.F., Marcel Dekker Inc., 1987.
3. Modern Machining Processes, Pandey P. C. and Shan H. S., McGraw Hill Education, 1980.
4. Mechanical Metallurgy, George E Dieter, McGraw Hill Education. 5. Elsevier, Springer, and Wiley ebooks from http://iitram.ac.in/library/index.php/ecollection/ebooks</td></tr>
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MASTER OF TECHNOLOGY

Mechanical Engineering Department

Semester - I

I	Course Code	**ME 5003**			
II	Course Title	**Design of Experiments**			
III	Credit Structure	L	T	P	C
		2	0	3	3
IV	Prerequisite(s), if any	None			
V	Course Objective	The course objective is to learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions. Both design and statistical analysis issues are discussed. Opportunities to use the principles taught in the course arise in all phases of engineering work, including new product design and development, process development, and manufacturing process improvement. Applications from various fields of engineering (including chemical, mechanical, electrical, materials science, industrial, etc.) will be illustrated throughout the course. Computer software packages (Design-Expert, Minitab) to implement the methods presented will be illustrated extensively.			
VI	Course Content	Overview and Basic Principles, Strategy, basic principle, guidelines and application of experiment design. Basic statistical concept, sampling and sampling distribution, hypothesis testing, sample size, confidence intervals. Simple Designs and Analysis of Variance, analysis of fixed effects model, model adequate checking, determining sample size, regression approach and nonparametric approach in ANOVA. Randomize block and Latin square design, Graeco-Latin Square design, balanced incomplete block design, overview of factorial design, two factorial and general factorial design, fitting response curve and surface, 2k factorial design, blocking and confounding in 2k factorial design, two level, three level, mixed level and fractional factorial design, fitting regression methods. Response surface methods and approaches to process optimization, method of steepest ascent, analysis of second order response surface, experimental design for fitting response surface, robust design, experiments with Random factors, Nested and split plot design.			

VII	Textbooks/References	1.Design and Analysis of Experiments, Montgomery, Wiley India. 2. Box, GEP, Hunter, WG, and Hunter, JS, 1978, Statistics for Experimenters, Wiley. 3. Sharma M K, Design and Analysis of Experiments, 2012, Prentice Hall India Learning Private Limited. 4. Winer BJ, 1962, Statistical Principles in Experimental Design, 2nd Edition, McGraw-Hill. 5. Krishnaiah K, Applied Design of Experiments and Taguchi Methods, Prentice Hall India Learning Private Limited, 2012. 6. Box, GEP and Draper, NR 1987, Empirical Model Building and Response Surfaces, Wiley. 7. Hinkelmann K and Kempthorne, O, 1994, Design and Analysis of Experiments (Vol I), Wiley. 8. Pukelsheim F, 1993, Optimal Design of Experiments, Wiley. 9. Wu C.F., Jeff and Michael Hamada, 2000, Experiments: Planning, Analysis, and Parameter Design Optimization, Wiley.

MASTER OF TECHNOLOGY

Mechanical Engineering Department

Semester - I

I	Course Code	**ME 5004**			
II	Course Title	**Elective I: Computational Methods in Engineering**			
III	Credit Structure	L	T	P	C
		3	0	0	3
IV	Prerequisite(s), if any	Familiarity with Undergraduate Mathematics and Computer Programming			
V	Course Objective	This course aims to familiarize students with the basics of solving engineering problems using computers. The entire gamut of topics from mathematical modelling of simple engineering problems to the interpretation and presentation of results is covered. Developing computer programs, to implement the numerical schemes discussed in lectures, is an integral component of this course.			
VI	Course Content	**Introduction to Numerical Analysis and Computation:** Floating Point Representation, Precision, Round-off Errors; A Brief Introduction to Computer Programming and MatLab **Modelling of Continuum Mechanical Problems:** Concise Introduction to Tensors and Index Notation; Conservation Laws of Mass, Momentum, and Energy for a Newtonian Fluid in Incompressible Flow; A Few Simple Structural Mechanics Models **Grid Generation:** Problem Domain Discretization; Types and Classification of Grids; Generation of Structured and Block- Structured Grids **Scalar Field Equations:** Steady and Unsteady Heat Conduction/ Diffusion Equation in One-Dimension with and without Source Terms; Finite Difference Methods, Taylor Series Expansion for Estimating Derivatives; Central Differencing, Implicit and Explicit Methods, Tridiagonal System of Algebraic Equations; Extension to Two-Dimensions, Alternating Direction Implicit (ADI) Methods, Higher Order Schemes; Elliptic (Laplace and Poisson) Equations **Advection and Advection-Diffusion Equations:** Exact Wave Solutions in One- and Two-Dimensions, Upwinding, Courant Number; Implicit and Semi-Implicit Schemes, Crank-Nicholson Method, Operator Splitting and ADI Methods, Diffusion Number and CFL Criterion **Navier-Stokes Equations:** Special Features, Pressure Velocity Coupling; Colocated and Staggered Grids; Pressure Poisson Equation; Pressure Correction Techniques; SIMPLE Methods **Properties of Numerical Schemes:** Consistency, Stability, Convergence; von Neumann Stability Analysis; Lax Equivalence Theorem; DuFort-Frankel Scheme; Conservation, Boundedness, Realizability, Accuracy; Modelling, Discretization, and Iteration Errors; Higher Accuracy via Modified Equation **Advanced Topics :** Finite Volume and Finite Element Methods; Probabilistic Simulation Techniques; High Performance Computation *(Depending on Class Interest and Progress)*			
VII	Course Outcome	Upon successful completion of this course, students will be equipped to represent and solve moderately complex engineering problems using a computer. They will be able to use advanced engineering software with an understanding of the background working. This knowledge will give students the confidence to question, validate, and understand results obtained using computer programs.			

VIII	Textbooks/References	1.Numerical Computing with MATLAB by Cleve Moler, Society for Industrial and Applied Mathematics 2004. 2. Computational Methods in Engineering by S. P. Venkateshan and Prasanna Swaminathan, Academic Press, Elsevier 2014. 3. Fundamentals of Engineering Numerical Analysis by Parviz Moin, Second Edition, Cambridge University Press, 2010. 4. Computational Methods for Fluid Dynamics by Joel H. Ferziger, and Milovan Perić, Third Edition, Springer - Verlag 2002. 5. Incompressible Flow by Ronald L. Panton, Third Edition, Wiley 2005. 6. Computational Engineering: Introduction to Numerical Methods by Michael Schäfer, Springer - Verlag 2006.