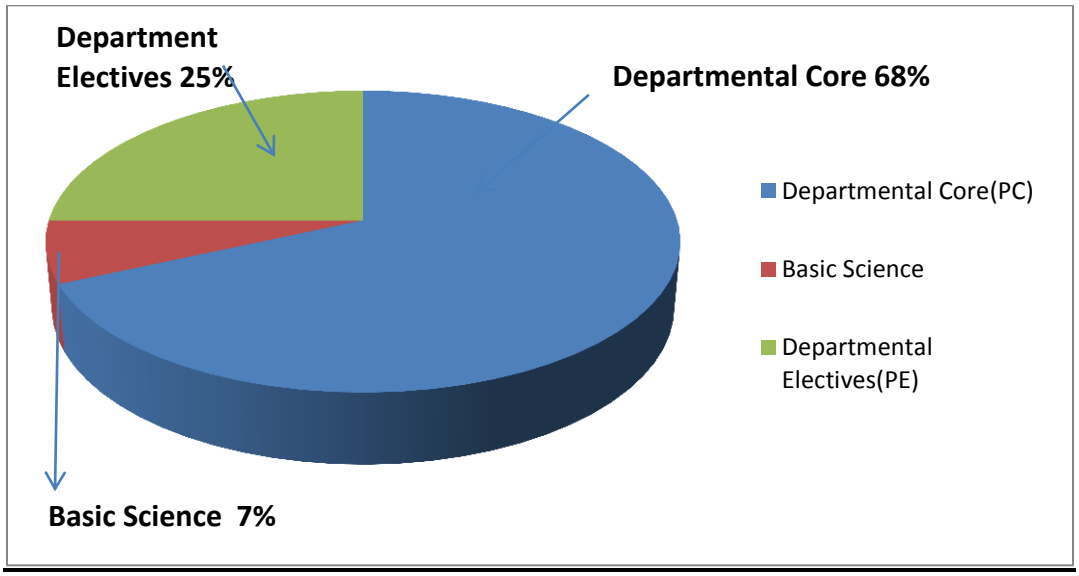
SIR PADAMPAT SINGHANIA UNIVERSITY
Udaipur
SCHOOL OF ENGINEERING

Course Structure of 2-Year M.Tech. Programme
in
Mechanical Engineering(Major in Design or Production Engg)
(2020-22 Batch)

Credit Structure

Postgraduate Core (PC)		**Postgraduate Elective (PE)**	
Category	Credits	**Category**	Credits
Departmental Core (DC)	24	Departmental Electives (DE)	15
Dissertation,Seminar, Viva	17		
Basic Sciences (BS)	4		
Total (PC)	45	**Total (PE)**	15
Grand Total (PC +PE)			60



Distribution of Total Credits and Contact Hours in All 4 Semesters

Sr. No.	Semester Number	Credits/Semester	Contact Hours/Semester
1	I	15	15
2	II	17	19
3	III	16	23
4	IV	12	24
		Total Credits=60	**Total Contact Hours=81**

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Semester I

Semester-I					
SubjectCode	**Name of the Subject**	**L**	**T**	**P**	**Total Credits**
MA-5001	Advanced Engineering Mathematics	3	0	0	3
ME-5001	Mechanical Vibration	3	0	0	3
ME-5002	Advanced Mechanics of Solid	3	0	0	3
ME-5003	Advanced Machining Processes	3	0	0	3
ME-5004	Mechanics of Machining	3	0	0	3
	Total Credits				**15**
	Total Contact Hours				**15**

Semester II

Semester-II					
Subject Code	**Name of the Subject**	**L**	**T**	**P**	**Total Credits**
ME-5010	Finite Element Methods in Engineering	3	0	2	5
ME-5011	Welding Science and Technology	3	0	0	3
ME-5XXX	Elective I	3	0	0	3
ME-5XXX	Elective II	3	0	0	3
ME-5XXX	Elective III	3	0	0	3
	Total Credits				**17**
	Total Contact Hours				**19**

Semester-III					
Subject Code	**Name of the Subject**	**L**	**T**	**P**	**Total Credits**
ME-5021	Composite Materials	3	0	0	3
ME-5022	Manufacturing Lab	0	0	2	2
ME-5XXX	Elective-IV	3	0	0	3
ME-5XXX	Elective-V	3	0	0	3
ME-5059	Dissertation Seminar I	-	-	-	2
ME-5060A	Dissertation I	-	-	-	3
	Total Credits				**16**
	Total Contact Hours				**23**

Semester-IV					
Subject Code	**Name of the Subject**	**L**	**T**	**P**	**Total Credits**
ME-5061	Dissertation Seminar II	-	-	-	1
ME-5060B	Dissertation II	-	-	-	8
ME-5062	Dissertation Viva	-	-	-	3
	Total Credits				**12**
	Total Contact Hours				**24**

Elective I, II and III (Production Engineering)

Sr No	Code	Name of the Subject	L	T	P	Total Credits
1	ME-5063	Mechanical Behavior of Materials	3	0	0	3
2	ME-5064	Computer Aided Design-Computer Aided Manufacturing	3	0	0	3
3	ME-5065	Advance Manufacturing Processes	3	0	0	3
4	ME-5066	Operation Research	3	0	0	3
5	ME-5067	Metal Casting	3	0	0	3

Elective I, II and III (Machine Design Engineering)

Sr No	Code	Name of the Subject	L	T	P	Total Credits
1	ME-5071	Tribology of Bearings	3	0	0	3
2	ME-5072	Nonlinear Vibrations	3	0	0	3
3	ME-5073	Fracture, Fatigue and Failure Analysis	3	0	0	3
4	ME-5074	Optimization Methods in Engineering	3	0	0	3
5	ME-5075	Industrial Noise Control	3	0	0	3

Elective IV & V (Production Engineering)

Sr No	Code	Name of the Subject	L	T	P	Total Credits
1	ME-5068	Flexible Manufacturing System	3	0	0	3
2	ME-5069	Production and Inventory Control	3	0	0	3
3	ME-5070	Machine Tool Design	3	0	0	3

Elective IV & V (Machine Design Engineering)

Sr No	Code	Name of the Subject	L	T	P	Total Credits
1	ME-5076	Condition Monitoring of Machines	3	0	0	3
2	ME-5077	Fracture Mechanics	3	0	0	3
3	ME-5078	Experimental Stress Analysis	3	0	0	3

Detailed Syllabus for M.Tech. Mechanical Engineering
Semester-I & II

MA-5001	3-1-0-4
Advanced Engineering Mathematics	L-T-P-C

Objective:

Vector and Tensor Analysis in Cartesian system, effect of rotation of coordinate systems. Review of ODEs; Laplace & Fourier methods, series solutions, and orthogonal polynomials. Sturm-Liouville problem. Review of 1st and 2nd order PDEs. Linear systems of algebraic equations. Gauss elimination, LU decomposition etc., Matrix inversion, ill-conditioned systems. Numerical eigen solution techniques (Power, Householder, QR methods etc.). Numerical solution of systems of nonlinear algebraic equations; Newton-Raphson method. Numerical integration: Newton-Cotes methods, error estimates, Gaussian quadrature. Numerical solution of ODEs: Euler, Adams, Runge-Kutta methods, and predictor-corrector procedures; stability of solutions; solution of stiff equations. Solution of PDEs: finite difference techniques. Probability and Statistics – Probability Distribution, Bays Theorem, Parameter Estimation, Testing of Hypothesis, Goodness of Fit. Laboratory: Basics of programming. Numerical experiments with the algorithms covered in class.

Texts/Reference Books:

[1] E. Kreyzig, Advanced Engineering Mathematics, New Age International, 1996.

[2] D. S. Watkins, Fundamentals of Matrix Computations, John Wiley, 1992.

[3] M. K. Jain, S. R. K. Iyengar, and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, 3rd Ed., New Age International, 1993

[4] D.S. Chandrashekaraiah and L. Debnath, Continuum Mechanics, Academic Press, 1994.

[5] M.K. Jain, S.R.K. Iyenger and R.K. Jain, Computational Methods for Partial Differential Equations, New Age International, 1994

[6] R. Courant and D. Hilbert, Methods of Mathematical Physics, Wiley, 1989.

[7] P.V. O'Neil, Advanced Engineering Mathematics, Cengage Learning, 2007

[8] G. B. Arfken, H. J. Weber and F.Harris, Mathematical Methods for Physicists, 5th Ed., Academic Press,

ME-5001	3- 0-0-3
Mechanical Vibrations	L-T-P-C

Objective: To impart the knowledge of single dgree nd multi degree vibration and its analysis

Generalised co-ordinates, constraints, virtual work; Hamilton's principle, Lagrange's equations; Discrete and continuous system; Vibration absorbers; Response of discrete systems - SDOF & MDOF: free-vibration, periodic excitation and Fourier series, impulse and step response, convolution integral; Modal analysis: undamped and damped non-gyroscopic, undamped gyroscopic, and general dynamical systems. Effect of damping; Continuous systems: vibration of strings, beams, bars, membranes and plates, free and forced vibrations; Raleigh-Ritz and Galerkin's methods. Measurement techniques.

Text/Reference Books:

[1] L Meirovitch, Elements of Vibration Analysis, McGraw Hill, Second edition, 1986.
[2] Meirovitch, Principles & Techniques of Vibrations, Prentice Hall International (PHIPE), New Jersey, 1997.
[3] W T Thomson, Theory of Vibration with Applications, CBS Publ., 1990.
[4] F S Tse, I E Morse and R T Hinkle, Mechanical Vibrations, CBS Publ., 1983.
[5] J S Rao and K Gupta, Theory and Practice of Mechanical Vibrations, New Age Publication, 1995

ME-5002	3- 0-0-3
Advanced Mechanics of Solids	L-T-P-C

Objective: This subject is designed to discuss the designing theories for different mechanical components

Analysis of Stresses and Strains in rectangular and polar coordinates: Cauchy's formula, Principal stresses and principal strains, 3D Mohr's Circle, Octahedral Stresses, Hydrostatic and deviatoric stress, Differential equations of equilibrium, Plane stress and plane strain, compatibility conditions. Introduction to curvilinear coordinates. Generalized Hooke's law and theories of failure. Energy Methods. Bending of symmetric and unsymmetric straight beams, effect of shear stresses, Curved beams, Shear center and shear flow, shear stresses in thin walled sections, thick curved bars. Torsion of prismatic solid sections, thin walled sections, circular, rectangular and elliptical bars, membrane analogy. Thick and thin walled cylinders, Composite tubes, Rotating disks and cylinders. Euler's buckling load, Beam Column equations. Strain measurement techniques using strain gages, characteristics, instrumentations, principles of photo-elasticity.

Text/Reference Books:

[1] L. S. Srinath, Advanced Mechanics of Solids, 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.

[2] R. G. Budynas, Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw Hill Publishing Co, 1999.

[3] A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 5th Edition, John Willey and Sons Inc, 1993.

[4] S. P. Timoshenko, J. N. Goodier, Theory of Elasticity, 3rd Edition, McGraw Hill Publishing Co. 1970.

[5] P. Raymond, Solid Mechanics for Engineering, 1st Edition, John Willey & Sons, 2001.

[6] J. W. Dally and W. F. Riley, Experimental Stress Analysis, 3rd Edition, McGraw Hill Publishing Co., New York, 1991.

ME-5003	3- 0- 0-3
Advanced Machining Processes	L-T-P-C

Objective: This course discusses gives the students in depth knowledge about the various modern manufacturing processes, their characteristics and process parameters.

General classification of unconventional machining processes; Abrasive jet machining, water jet and abrasive water jet machining, ultrasonic machining; Electric discharge machining and allied processes, laser beam machining, ion beam machining, plasma arc machining; Electro chemical machining (ECM) and allied processes, ECM tool design, chemical machining, photochemical machining; Elastic emission machining; Advanced finishing processes, abrasive flow finishing, magnetic abrasive finishing, magnetorheological finishing, chemomechanical polishing; Comparative evaluation of different unconventional machining processes; Analytical modeling of mechanical, thermal and electrochemical type nontraditional machining processes; Numerical modeling and simulation of unconventional machining processes; Computer aided process planning of non-traditional machining processes.

Text/Reference Books:

[1] V. K. Jain, Advanced Machining Processes, Allied Publishers,2009.

[2]]Gary F. Benedict, Nontraditional Manufacturing Processes, Taylor & Francis, 1987.

[3] J. A. McGeough, Advanced Methods of Machining, Springer, 1988.

References:

[1] P K Mishra, Non Conventional Machining, Narosa India Publication, 1997.

[2] Hassan El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill Prof Med/Tech, 2005.

[3] P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill Education, 1980.

[4] James A. Brown, Modern Manufacturing Processes, Industrial Press, 1991.

[5] V. K. Jain, Introduction to Micromachining, Alpha Science International Limited, 2010.

[6] J. A. McGeough, Micromachining of Engineering Materials, Taylor & Francis, 2001.

ME-5004	3- 0- 0-3
Mechanics of Metal Cutting	L-T-P-C

Objective: This course is designed to discuss analysis of machining process and tool failure.

Principles of metal cutting; Mechanics of chip formation; Geometry of cutting tools and tool signatures; Orthogonal and oblique cutting; Metal cutting models: Merchant model, Lee- Shaffer model, Oxley model; Forces in metal cutting; Tribology in metal cutting; Surface roughness in machining; Thermal aspects of machining; Tool wear, tool life, tool materials, tool coatings and coating techniques; Economics of machining; Machinability; Cutting fluids: properties, types, application techniques, emissions and its adverse effects; Recent advances in machining: hard turning, high seed machining, diamond turning, machining of advanced materials, machining with minimum quantity cutting fluids and cryogenic fluids; Grinding: mechanics, forces, specific energy, temperature, wheel wear and surface finish; Other conventional finishing processes: honing, lapping, super finishing; Applications of FEM and optimization to machining as well as finishing.

Texts/Reference Books:

[1] M. C. Shaw, Metal Cutting, Tata McGraw Hill, New Delhi, 2004.

[2] M. C. Shaw, Principles of Abrasive Processing, Oxford University Press, 1996.

[3] G. K. Lal, Introduction to Machining Science, New Age International Publishers, 2007.

[4] G. Boothroyd and W. A. Knight, Fundamentals of Machining and Machine Tools, CRC-Taylor and Francis, 2006.

[5] A. Ghosh and A. K. Malik, Manufacturing Science, East West Press, 2010.

[6] R. A. Lindberg, Processes and Materials of Manufacture, PHI Learning, 2013.

[7] P. H. Black, Metal Cutting Theory, McGraw Hill, 1961.

ME-5010	3- 0- 2-5
Finite Element Methods in Engineering	L-T-P-C

Objective: This course deals with finite element method as a tool for solving various engineering problems computationally.

Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method; Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post processing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame. Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics; Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about preprocessors, postprocessors and finite element packages.

Text/Reference Books:

[1] J N Reddy, An introduction to the Finite Element Method, McGraw-Hill, New York, 1993.

[2] R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3d ed., John Wiley, New York, 1989.

[3] K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.

[4] T J T Hughes, The Finite Element Method, Prentice-Hall, Englewood Cliffs, NJ, 1986

[5] O C Zienkiewicz and R L Taylor, The Finite Element Method, 3d ed. McGraw-Hill, 1989.

ME-5011	3- 0- 0-3
Welding Science and Technology	L-T-P-C

Objective: The course is designed to give advanced knowledge on welding techniques and testing.

Introduction and classification of welding; Design principles of welded structures; Welding methods – shielded metal arc welding, gas tungsten arc welding, gas metal arc welding, flux cored arc welding, submerged arc welding, plasma arc welding, electroslag welding, electrogas welding, arc stud welding, synergic and pulsed welding, friction welding, Oxy-fuel gas welding, resistance welding, brazing, soldering; Types of power source and their characteristics; Physics of welding arc – characteristics of arc, mode of metal transfer, forces acting on a molten droplet; Welding fluxes and coatings - type and classification; Study and analysis of heat flow, cooling rates, models for welding heat sources; Testing of welds, fracture and fatigue of welded structures, welding metallurgy, heat treatment of welds, effect of alloying materials; Welding symbols, standards and codes; Welding process modeling using ANN and Fuzzy.

Textbooks/References:

[1] O'Brien, Welding Handbook: Welding Processes, Part 1, Vol. 2, AWS, 2004.
[2] J. F. Lancaster, The Physics of welding, Pergamon, 1986.
[3] R. W. Messler, Principles of Welding, John Wiley and Sons, 1999.
[4] O. Grong, Metallurgical modelling of welding, 2nd Ed, IOM Publication, 1997.
[5] V.M. Radhakrishnan, Welding technology and design, New age, 2002.
[6] J. A. Goldak, Computational welding mechanics, Springer, 2005.
[7] L-E Lindgren, Computational welding mechanics, Woodhead Publishing Limited 2007.

Detailed Syllabus for M.Tech. Mechanical Engineering
Semester-III

ME-5057	3- 0- 0-3
Composite Materials	L-T-P-C

Objctives: The course deals processing and behavior of composite materials.

Introduction – classifications, terminologies, manufacturing processes (in brief). Macromechanical analysis of lamina – Hooke's law for anisotropic, monoclinic, orthotropic, transversely isotropic and isotropic materials–2D Unidirectional and angle ply lamina –Strength theories of lamina. Micromechanical analysis of lamina –Volume and mass fraction,density and void content – Evaluation of Elastic modulii, Ultimate strength of unidirectional lamina. Macromechanical analysis of laminates – Laminate code, Stress strain relations – Inplane and Flexural modulus,Hygrothermal effects. Failure Analysis and Design – Special cases of laminates, symmetric, cross ply, angle ply and antisymmetric laminates, failure criteria and failure modes

Text/Reference Books:

[1] Jones, R M, *Mechanics of Composite Materials*, Scripta Book Co.

[2] Agarwal, B D and Broutman, J. D, *Analysis and Performance of Fiber Composites*, New York, John Willey and Sons, 1990

[3] Mallik, P. K, *Fiber reinforced composites : materials, manufacturing and design,* New York- Marcel and Dekker, 1993 (2ndedition)

[4] Arthur, K Kaw, *Mechanics of Composite Materials*, CRC Press, 1997.

[5] Reddy J N, *Mechanics of Laminated Composite Plates*, CRC Press

[6] Mallik, P. K, *Composite Engineering Hand Book*, New York, Marcel and Dekker, 1997 (2nd edition)

ME-5058	0- 0- 2-2
Manufacturing Lab	L-T-P-C

Objective: This course is designed to train the students to find out various parameters of machining and also to teach them automation.

Measurement of cutting forces, surface roughness, tool wear, dimensional deviation and vibrations in machining. Measurement of chip thickness ratio and temperature in machining. Measurement of microhardness. . Sensors and transducers. PID controller. Study of robots. CNC programming. Design of simple electronic circuits. Microprocessors and PLCs for manufacturing applications.

Electives I, II and III(Production Engineering)

ME-5063	3- 0- 0-3
Mechanical Behavior of Materials	L-T-P-C

Objctives: To develop understanding of behavior of materials for engineering Design.

Introduction: review of elastic and plastic behavior and crystal structure of materials; Isotropic and anisotropic properties of cubic and noncubic crystals; Crystal plasticity: dislocation geometry and energy, dislocation mechanics, slip system, hardening, yield surface, micro-to-macro plasticity; Strain-rate and temperature dependence of flow stress, superplasticity; Mechanical Twining, Martensitic transformation, Shape memory and superelasticity; Hardening mechanisms in metals; Concept of fatigue, fracture, creeps and stress rupture; Rheological behavior: Viscoelasticity; Residual stress; Flow and deformation behavior of polymer, ceramics and glasses; Deformation behavior of metal sandwich plate and metal-matrix composite material

Text/Reference Books:

[1] William F. Hosford, Mechanical Behaviour of Materials, Cambridge University Press, New York, USA, 2005.

[2] Marc A. Meyers and Krishan Kumar Chawla, Mechanical Behaviour of Materials, 2nd revised eds, Cambridge University Press, New York, USA, 2008.

[3] D.W.A. Rees, Basic Engineering Plasticity, Elsevier India, New Delhi, 2008.

[4] C Lakshmana Rao and Abhijit P Deshpande, Modelling of Engineering Materials, Ane Books Pvt. Ltd., New Delhi, India, 2010.

[5] John D. Verhoeven, Fudamentals of Physical Metallurgy, Wiley, 1975.

[6] TH Courtney, Mechanical Behaviour of Materials, 2nd eds, McGraw-Hill International eds, 2000.

[7] G E Dieter, Mechanical metallurgy, 3rd revised eds, Mgh, 1989.

[8] Donald R. Askeland and Pradeep P. Phule, The Science and Engineering of Materials, 4th Eds, Thomson, Singapore, 2003.

[9] J. Chakrabarty, Theory of plasticity, 3rd Eds, Elsevier India, 2009.

ME-5064	3- 0- 0-3
Computer Aided Design-Computer Aided Manufacturing	L-T-P-C

Objctives: The main objective of the course is to bring the detail application of CAD

Introduction and components of Computer aided design (CAD)/Computer aided manufacturing (CAM)/Computer aided engineering (CAE) systems; Basic concepts of graphics programming; Transformation matrix; Rendering; Graphical user interface; Computer aided drafting systems; Geometric modeling systems – wireframe, surface and solid modeling systems; Nonmanifold systems; Assembly and web-based modeling systems; Representation and manipulation of conic sections; Hermite, Bezier, and B-spline curves and surfaces; Introduction to optimization; CAD/CAM integration; Numerical control – Concepts for manual and computer assisted part programming; Virtual engineering – components and applications;

Text/Reference Books:

[1] Kunwoo Lee, *Principles of CAD/CAM/CAE systems*, Addison Wesley, 1999.

[2] Mark E. Coticchia, George W. Crawford, and Edward J. Preston, *CAD/CAM/CAE systems: justification, implementation and productivity measurement*, 2nd edition, New York, Marcel Dekker, 1993.

[3] Chris Macmahon and Jimmie Browne *CADCAM: principles, practice and manufacturing management*, 2nd edition, Addison Wesley, 1998.

[4] Mikell P. Groover and Emory W. Zimmers ,*CAD/CAM: Computer aided design manufacturing*, Prentice Hall, 1996.

[5] P. Radhakrishnan, S. Subramanyan, and V. Raju, *CAD/CAM/CIM* , 2nd edition, New Age, 2000.

ME-5065	3- 0- 0-3
Advanced Manufacturing Processes	L-T-P-C

Objctives: To expose the students to the various advanced manufacturing processes, their need, evolution, capabilities, and applications

Advanced Casting Processes: Non-ferrous mould casting, continuous casting, squeeze casting, vacuum mould casting, evaporative pattern casting, ceramic shell casting, etc.

Advanced Joining Processes: Details of electron beam welding (EBW); laser beam welding (LBW), ultrasonic welding (USW), Explosive welding, Plasma arc welding (PAW), Infrared welding, microwave welding, etc.

Advanced Forming Processes: Details of high energy rate forming (HERF) processes such electro-magnetic forming, explosive forming, electro-hydraulic forming; Stretch forming; Contour roll forming; Laser bending, etc.

Additive Manufacturing Processes: Concept of reverse engineering (RE), rapid prototyping (RP), and rapid tooling (RT); Various RP process such as Liquid based RP methods – Stereolithography apparatus (SLA), Solid Ground Curing (SGC), Solid Creation System (SCS), etc. Solid based RP methods: Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), etc. Powder based RP methods– Selective Laser Sintering (SLS), 3D printing (3DP), Ballistic Particle Manufacturing (BPM), etc.

Text/Reference Books:

1. G. F. Benedict, Nontraditional Manufacturing Processes, Marcel Dekker, Inc. New York, 1987, ISBN: 9780470924679.

2. Heine and Roshenthal, Principles of Metal casting, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1983, ISBN 007- 099-3483.

3. C. K. Chua, and K. F. Leong, Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons. Inc. Singapore, 1997, ISBN: 9789812381200.

4. E. P. DeGarmo, J. T Black, R. A. Kohser, Materials and Processes in Manufacturing (8^{th} Edition), Prentice Hall of India, New Delhi, 1997, ISBN: 0-02-978760.

5. P. C. Pandey, and H.S. Shan, Modern Machining Processes, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1980, ISBN: 0-07-096553-6.

6. V. K. Jain, Advanced Machining Processes, Allied Publishers, New Delhi, 2002, ISBN: 81-7764-294-4.

ME-5066	3- 0- 0-3
Operation Research	L-T-P-C

Objctives: **T**his course provides an in depth knowledge to operations research techniques. The students would understand to model decision problems using operation research.

Introduction: Origin and development of operations research, general methodology of OR, applications of OR to industrial problems.

Linear Programming Problems: Different types of models, formulation of linear programming problems (LPPs), product-mix problems, deterministic models, graphical solution.

Simplex Method: Simplex algorithm, computational procedure in simplex method, applications of simplex technique to industrial problems.

Duality and Sensitivity: Duality and its concept, dual linear programming, application of elementary sensitivity analysis.

Linear Optimization Techniques: Integer programming problems (IPPs), assignment models: mathematical formulation, methods of solutions, transportation problems: methods of obtaining optimal solution degeneracy in transportation problems, transshipment problems.

Game Problems: Introduction and scope of game problems in business and industry, min-max criterion and optimal strategy, solution of two-person zero-sum game, game problem as a special case of linear programming.

Queuing Problems: Queuing systems and concepts, classification of queuing situations; Kendall‟s notation, solution of queuing problems, single channel, single stage, finite and infinite queues with Poisson arrival and exponential service time, applications to industrial problems

Text/Reference Books:

1. H.A. Taha, An Introduction to Operations Research (6th edition), Prentice Hall of India, 2001.
2. F.J. Hillier, G.J. Lieberman, Introduction to Operations Research (7th edition), Holden Day Inc., 2001.
3. H.M. Wagner, Principles of Operations Research, Prentice Hall of India, 1980,.
4. D. Gross, and C.M. Harris, Fundamentals of Queuing Theory (2nd edition), John Wiely & sons, New York, 1985,

ME-5067	3- 0- 0-3
Metal Casting	L-T-P-C

Objctives: The course imparts the knowledge of casting process and its analysis

Organization of process preparation, principal conditions for execution of an order and process design, stages of foundry process design, principal rules for design of castings. Bonding action of clays, properties of moulding sands, facing and cushion materials. Additives. Pattern layout and construction. Colours and storing of patterns. The design and location of feeder heads, feeder head size, shape and location. Design and economic considerations. The D process, investment casting from permanent patterns, unorthodox shaping techniques, techniques relating to metal structure and quality, antioch process, continuous casting.

Concept of solidification of metals, nucleation and growth. Coring. Fettling and salvaging of castings, heat treatment of castings. Casting Defects. Need for modernization and mechanization. Areas for mechanisation, plant lay out for foundries. Aluminum, copper and magnesium foundry practices.

References:

1. P. L. Jain , Principles of Foundry Technology, Tata Mc Graw Hill, 2001.

2. Heine, Loper and Rosenthal , Principles of Metal Casting, Tata Mc Graw Hill, 1996

3. O. P. Khanna and M. Lal , Text Book of Foundry Technology, Dhanpat Rai and Sons, 1993.

4. John Campbell, Castings, Elsevier, 2004.

5. A. K. Chakraborti, Casting Technology and Cast Alloys, Prentice hall India, 2005.

Electives III and IV (Production Engineering)

ME-5068	3- 0- 0-3
Flexible Manufacturing System	L-T-P-C

Objctives: An advanced course in FMS dealing with optimum use of flexibility. Recent advancements in scheduling and loading is also included.

Introduction: Introduction to Manufacturing Systems, Different types of manufacturing systems, Volume Variety relationships for understanding manufacturing systems

Flexibility and automation: Different types of flexibility in manufacturing, Different types of FMS building blocks. Work station, Storage retrieved system, material handling systems, computer control system.

Machining system of FMS: Horizontal machining Centers, Vertical machining Centers, Integrated Material Handling, Automated Guided Vehicles, Automatic Storage and Retrieved System

Group technology: Part classification and coding, production flow analysis, Machine Cell design, Computer Aided Process Planning. Layout consideration for flexible manufacturing, Scheduling of flexible manufacturing system. FMS simulation

Text/Reference books:

1. Automation, Production Systems and Computer integrated Manufacturing by MP. Groover.
2. Hand-book of Flexible Manufacturing Systems by Nand K. Jha.

ME-5069	3- 0- 0-3
Production and Inventory Control	L-T-P-C

Objctives: This course is designed to discuss about scheduling and inventory control

Production System, Types, Characteristic features and applications, Demand forecasting, Functions, Horizons, Techniques and applications, Error analysis, Production planning, Different production strategies, Aggregate planning, Master production scheduling, Material requirement planning, Supply chain management, Production control, Inventory control, Deterministic and stochastic models, Economic order quantity, Economic run length, Relationship with production control, Computer applications in production planning and control.

Text/Reference Books:

1. Krajewski, L. J., Ritzman, L. P. and Manoj, K. M., Operations Management (Processes and Value Chains), Prentice Hall of India (2007).
2. Chase, R.B., Aquilano, N.J. and Jacob, S.R., Production and Operations Management – Manufacturing and Services, McGraw Hill (2008).
3. Monks, J.G., Operations Management (Theory and Problems), McGraw Hill (1987).
4. Ebert, R.J. and Adam, E.E., Production/Operations Management – Concepts, Models andBehaviour, Prentice Hall of India (1998).

ME-5070	3- 0- 0-3
Machine Tool Design	L-T-P-C

Objctives: The scope of this course is to impart the knowledge of designing of different components of machine tool.

Introduction to Machine Tools and Mechanisms:
General principles of machine tool design, working and auxiliary motions, machine tool drives, hydraulic and mechanical transmission and its elements, general requirements of machine tool design, layout of machine tools. Regulation of Speed and Feed Rates: Purpose, stepped regulation of speed-design of speed box, machine tool drives using multiple speed motors, developing the gearing diagram, step-less regulation of speed and feed rates.

Machine Tool Structure: Functions and requirements, design criteria, materials used and their properties, static and dynamic stiffness, cross-sectional shapes used for machine tool structures and basic design procedure for the design of beds, columns and other structural elements, model techniques used design,introduction to Finite Element Method (FEM).

Guideways and Power Screws: Function and types, design considerations & procedure for slideways, design of power screws.

Spindles and Spindle Supports: Functions and requirements, materials, effect of machine tool compliance on machining accuracy, design of spindles, bearings design/selection. Control Systems: Functions, requirements and classification, control systems for speeds, feeds & auxiliary motions, manual control systems, automatic control systems, adaptive control systems, criteria and economic selection of machine tools, future trends in development of machine tools.

Text/Reference Books:
1. Donaldson of al Tool Engineering, Tata Mc-Graw Hill, 1980.
2. Pollack, H.W. Tool Design, Reston Publishing Company, Inc. 1966
3. Kempster, M.H.A. Principles of Jig and Tool Design, English University Press Ltd.
4. Machine Tool Design and Numerical Control by Mehta N.K. TMH

Electives I, II and III(Machine Design Engineering)

ME-5071	3- 0- 0-3
Tribology of Bearings	L-T-P-C

Objctives: This course discuss the theory of bearing and lubrication.

Introduction, Properties and Testing of Lubricants, Basic Equations, Idealized Hydrodynamic Bearings. Finite Bearings, Oil Flow and Thermal equilibrium, Bearing Design, Squeeze Film bearings, Hydrodynamic Instability. Externally pressurized Oil Bearings. Gas-lubricated Bearings. Elastohydrodynamic Lubrication, Surface Roughness Effect on Hydrodynamic Bearings and Elastohydrodynamic Line contacts. Ball Bearings, Roller Bearings. Friction of Metals. Wear of Metals.

Text/Reference books:

[1] B C Majumdar, 1999, "*Introduction to Tribology of Bearings*", A. H. Wheeler & Co. Ltd., New Delhi.

[2] Pinkus, O. and Sternlicht, B., 1961, "*Theory of hydrodynamic lubrication*", Mc Graw Hill Book Co. Inc., New York.

[3] A Cameron and C.M. Mc Ettles, 1987, "*Basic Lubrication Theory*", Wiley Eastern Ltd., New Delhi.

ME-5072	3- 0- 0-3
Nonlinear Vibrations	L-T-P-C

Objctives: This course discuss the non linear vibration and its analysis

Mechanical Vibrations Dynamics of conservative and non-conservative systems; Phase planes, fixed points; Local and global stability, Lyapunov theory; Analytical solution methods: Harmonic balance, equivalent linearization, perturbation techniques (Linstedt-Poincare, Multiple Scales, Averaging – Krylov-Bogoliubov-Mitropolsky); Damping mechanisms; self-excited systems, Van der Pol's oscillator. Forced oscillations of SDOF systems, Duffing's oscillator; primary-, secondary-, and multiple- resonances; periodmultiplying bifurcations; Poincare' maps, point attractors, limit cycles and their numerical computation, strange attractors and chaos; Types of bifurcations, Lyapunov exponents and their determination, fractal dimension. Parametric excitations, Floquet theory, Mathieu's and Hill's equations; effects of damping and nonlinearity; MDOF systems, solvability conditions, internal (autoparametric) resonances; Hopf bifurcation and panel flutter example. Application to continuous systems.

Text/Reference books:

[1] Nayfeh, A. H., and Mook, D. T., *Nonlinear Oscillations*, Wiley-Interscience, 1979..

[2] Hayashi, C. *Nonlinear Oscillations in Physical Systems*, McGraw-Hill, 1964.

[3] Evan-Ivanowski, R. M., *Resonance Oscillations in Mechanical Systems*, Elsevier, 1976.

[4] Nayfeh, A. H., and Balachandran, B., *Applied Nonlinear Dynamics*, Wiley, 1995.

[5] Seydel, R., *From Equilibrium to Chaos: Practical Bifurcation and Stability Analysis*, Elsevier, 1988.

[6] Moon, F. C., *Chaotic & Fractal Dynamics: An Introduction for Applied Scientists and Engineers*, Wiley, 1992.

[7] Srinivasan, P. *Nonlinear Mechanical Vibrations*, New Age International, 1995.

[8] Rao, J. S., *Advanced Theory of Vibration: Nonlinear Vibration and One-dimensional Structures*, New Age International, 1992.

ME-5073	3- 0- 0-3
Fracture, Fatigue and Failure Analysis	L-T-P-C

Objctives: This course discuss the fracture and propagation in detail with analysis.

Griffith's theory of brittle failures; Irwin's stress intensity factors; Linear elastic fracture mechanics: The stress analysis of crack tips, Macroscopic theories in crack extension, Instability and R-curves, Crack tip plasticity, K as a failure criterion, Mixed mode of fracture, Analytical and Experimental methods of determining K; Elastic plastic fracture mechanics: Crack tip opening displacement, J Integrals, Crack growth resistance curves, Crack tip constraint under large scale yielding, creep crack growth; Microscopic theories of fracture: Ductile and cleavage fracture, ductile-brittle transition, inter-granular fracture; Fatigue crack propagation: Fatigue crack growth theories, crack closure, Microscopic theories of fatigue crack growth; Application of theories of fracture mechanics in design and materials development

Text/Reference book:

[1] T. L. Anderson, *Fracture Mechanics Fundamentals and Applications,* CRC Press, 1994

[2] D. Brock, *Elementary Engineering Fracture Mechanics*, Maritinus Nijhoff Publishers, 1982.

[3] S. T. Rolfe and J. M. Barson*, Fracture and Fatigue Control in Structures*, PHI, 1977

ME-5074	3- 0- 0-3
Optimization Methods in Engineering	L-T-P-C

Objctives: The objective of the course is to provide the students the basic concepts of optimization problems, decision analysis, non-linear optimization, non-traditional optimization and NP-Complete problems.

Introduction to optimization; Formulation of optimization problems; Classical optimization techniques; Linear Programming; Non-linear Programming; single variable, multi-variable and constrained optimization; Specialised algorithms for integer programming and geometric programming; Non-traditional optimization algorithms

Text/Reference books:

[1] S. S. Rao, Optimization: *Theory and Applications*, 2nd ed. Wiley Eastern, 1984.

[2] K. Deb, *Optimization for Engineering Design-Algorithms and Examples*, Prentice-Hall India, 1995.

[3] J. S. Arora, *Introduction to Optimum Design*, MCGraw-Hill, 1989.

[4] G. V. Reklaitis, A. Ravindran and K. M. Ragsdell, *Engineering Optimization-Methods and Applications*, Wiley, 1983

[5] R. L. Fox, *Optimization Methods for Engineering Design*, Addison Wesley, 1971.

ME-5075	3- 0- 0-3
Industrial Noise Control	L-T-P-C

Objctives: This course discusses the noise measurement , sources and control in detail.

Principles of sound generation and propagation, sound attenuation, sound absorption, sources of industrial noise, effects of noise, noise measurement units and instruments, identification of source of noise, noise evaluation procedures, acoustical enclosures, design of reactive and absorptive mufflers, active noise control, designing for quieter machines and processes, case studies.

Text/Reference books:

[1] Leo L. Beranek, *Noise and Vibration Control*, McGraw-Hill, 1971

[2] J. D. Irwin and E. R. Graf, *Industrial Noise and Vibration Control*, Prentice Hall, 1979

[3] Cyril M Harris, *Handbook of Noise Control*, McGraw-Hill

[4] Baxa, *Noise Control in Internal Combustion Engines*, Wiley, 1982

[5] Harold Lord, Gatley and Eversen, *Noise Control for Engineers*, McGraw-Hill

[6] R. H. Lyon, *Machinery Noise and Diagnostics*, Butterworths, 1987.

Electives IV and V (Machine Design Engineering)

ME-5076	3- 0- 0-3
Condition Monitoring of Machines	L-T-P-C

Objctives: This course is intended to impart knowledge regarding the structural health monitoring based on acquired vibration signals.

Introduction to machinery maintenance, basic vibration theory, fundamentals of data acquisition, principles of condition monitoring, transducers for condition monitoring, fault diagnosis in rotating machines, NDT methods in condition monitoring, wear and debris analysis, case studies in condition monitoring.

Text/ Reference books:

[1] R. A. Collacott, *Vibration Monitoring and Diagnosis*, Willey, New York, 1979

[2] H. P. Bloch and F. P. Geitner, *Practical Machinery Management for Process Plants*, Vol. 1, 2 3 & 4., Gulf Publishing Company, 1983

[3] H. M. Harris and C. E. Crede, *Shock and Vibration Handbook*, McGraw-Hill Book Company, 1994

[4] A. V. Oppenheim and R.W. Shafer, *Digital Signal Processing*, Prentice-Hall, Inc., 1975

[5] V. Wowk, *Machinery Vibration Measurement and Analysis*, McGraw-Hill, Inc., 1991

[6] R. B. Randall, *Frequency Analysis*, Bruel & Kjaer Publication, 1986

[7] J. S. Bendat and A. G. Piersol, *Engineering applications of correlation and Spectral Analysis*, John Wiley & Sons, 1980

ME-5077	3- 0- 0-3
Fracture Mechanics	L-T-P-C

Objctives: This course discusses nucleation and propagation of cracks and prevention.

Fracture criteria, Introduction to linear elastic fracture mechanics, Analysis of simple crack problems, Nucleation and propagation of cracks, Correlation between microstructure and fracture behaviour in materials. Mechanisms of fracture, Mechanisms of fatigue crack initiation and propagation, Evaluation of fracture toughness, factors influencing fatigue strength, life prediction, prevention of fatigue failure

Text/Reference books:

[1] S.T. Rolfe and J.M Barson, *Fracture and fatigue control in structures*, Prentice Hall

[2] David and Bruck, *Elementary Engineering Fracture Mechanics*, Norelho

[3] N.E. Fros, et al, *Metal fatigue*, Clarendon Press

[4] American Society for Metals, *Case histories in failure analysis*, ASM.

ME-5078	3- 0- 0-3
Experimental Stress Analysis	L-T-P-C

Objctives: This course discuss the measurement and analysis methods for stress and strain

Review of analysis of stress and strain – basic equations of elasticity. Introduction to ideal requirements of strain measuring devices – mechanical, optical and electrical strain gauges Electrical Resistance Strain Gauges -- Gauge Factor, Types, Gauge materials, Backing Materials, Adhesives, Protective Coatings, Bonding of Strain Gauges, Lead wires and connections, Semiconductor strain gauges Performance of Strain Gauges – Temperature compensation, Transverse sensitivity, Gauge Length, Response, Excitation level, Stability. Strain Gauge Circuits and recording instruments, Strain Gauge Rossetes analysis, Stress Gauge. Photoelasticity methods - behaviour of light, plane polarized and circular polariscope, isochromatic and isoclinic fringe patterns for two dimensional photoelasticity, three dimensional photoelasticity, model slicing and shear difference method, birefringent coating method. Introduction to brittle coating method and Moire Fringe technique.

Textbooks/References Books:

[1] J. W. Dally and W. P. Riely, *Experimental Stress Analysis*, McGraw-Hill Book Co.

[2] L. S. Srinath, M. R. Raghavan, *Experimental Stress Analysis*, Tata McGraw-Hill.

[3] A. W. Hendry, *Elements of Experimental Stress Analysis*, Pergamon Press.