MAHATMA GANDHI UNIVERSITY

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

MECHANICAL ENGINEERING

WITH SPECIALIZATION IN

ADVANCED MANUFACTURING ENGINEERING AND

PRODUCTION MANAGEMENT

(2013 ADMISSION ONWARDS)

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN MECHANICAL ENGINEERING WITH SPECIALIZATION IN ADVANCED MANUFACTURING ENGINEERING AND PRODUCTION MANAGEMENT

SEMESTER-I

Sl. No.	Course Number	Subject	Hrs/Week			Evaluation Scheme (Marks)					Credits
						Sessional Exam (internal)			ESE (Theory / Practical)	Total	
			L	T	P	TA	CT	Sub Total			
1	MMEMP 101[$]	Advanced Engineering Materials and Processing	3	1	0	25	25	50	100	150	4
2	MMEMP 102[$]	Manufacturing Systems Management	4	0	0	25	25	50	100	150	4
3	MMEMP 103	Computer Integrated Manufacturing	4	0	0	25	25	50	100	150	4
4	MMEMP 104[$]	Quality Engineering and Management	4	0	0	25	25	50	100	150	4
5	MMEMP 105	Professional Elective – I	3	0	0	25	25	50	100	150	3
6	MMEMP 106	Professional Elective – II	3	0	0	25	25	50	100	150	3
7	MMEMP 107	Manufacturing and Precision Engineering Laboratory	0	0	3	25	25	50	100	150	2
8	MMEMP 108	Seminar - I	0	0	2	50	-	50	0	50	1
			22	0	5			400	700	1100	25

Elective – I (MMEMP 105)		**Elective – II (MMEMP 106)**	
MMEMP 105-1[$]	Metrology and Computer Aided Inspection	MMEMP 106-1[$]	Production Scheduling
MMEMP 105-2[$]	Tooling for Manufacturing and Automation	MMEMP 106-2	Maintenance Engineering and Management
MMEMP 105-3[$]	Finite Element Method	MMEMP 106-3[$]	Financial Engineering and Economics
MMEMP 105-4[$]	Advanced Powder Metallurgy	MMEMP 106-4	Advanced Engineering Mathematics

TA – Teachers Assessment (Quizzes, attendance, group discussion, tutorials, seminar, field visit etc)

CT – Class Test; Minimum two tests conducted by the institute

ESE – University End Semester Exam will be conducted by the institute through concerned affiliating University.

L - Lecture, T - Tutorial, P - Practical

\$ Common subjects

MMEMP 101 **ADVANCED ENGINEERING MATERIALS AND PROCESSING**

L	T	P	C
3	1	0	4

Objectives

1. *To provide fundamental concepts of atomic structure, chemical bonds, crystal structure of metals with mechanical behavior of metals.*
2. *Understand the strengthening mechanisms of different types of metals.*
3. *To enable students to be more aware of the behavior of materials in engineering applications and select the materials for various engineering applications.*

Module 1

Origin of crystal clear concept - **atomic structure**: correlation of atomic radius to strength, electron configurations - primary bonds: classification- bond energy, cohesive force, density, directional and non-directional, conductivity and non conductivity, opaque, lustrous, density etc.– Specific properties of bonding: Deeper energy well and shallow energy well bond, melting temperature, modulus of elasticity, coefficient of thermal expansion and attributes of modulus of elasticity in metal cutting process, problems - secondary bonds: classification, hydrogen bond, specific heat etc.

Crystallography: BCC, FCC, HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties-determination of atomic packing factor of SC, BCC, FCC, HCP and diamond - coordination number – linear and planar densities, problems – applications of miller indices: slip system, brittleness of BCC, HCP and ductility of FCC- Schmid's law applications, problems.

Mechanism of **crystallization** - effects of grain size, grain size distribution, grain shape, grain orientation on dislocation movement/strength and creep resistance - Hall - Petch relation, problems - significance high and low angle grain boundaries on dislocation - polishing and etching to determine the microstructure - modes of **plastic deformation**: Von Mises' yield criterion basic only

Module 2

Imperfections, problems - role of surface defects on crack propagation – forest of dislocation - Burgers vector - correlation of dislocation density with strength - significance of **Frank and Read source** in materials deformation - **Phase diagrams:** Limitations of pure metals and need of alloying - Hume Rothery`s rule - **Intermetallics**: property prediction, phase diagrams, Electron (or Hume - Rothery) compounds and Laves phase, AB_2 structures.

Maraging steel: History of maraging steel development - reaction in austenite - reaction in martensite - austenite to martensite transformation – effect of aging time - effects of maraging with cobalt, cobalt free, molybdenum and other alloying elements - variation of mechanical properties: yield strength, hardness and fatigue - effect of precipitate size - fracture toughness and weldability, hardness variation in welded zone - manufacturing steps of rings- applications - special advantages and limitations - comparison of production sequence with high tensile steel.

Ceramics: AX, AmXp, AmBmXp type crystal structures – imperfections in ceramics, stoichiometric defect reactions – stress strain behavior – applications.

Module 3

High temperature **super alloys**: Characteristics of high-temperature materials- instances of superalloy component failures, gas turbine engine requirement- selection of materials for high-temperature applications, Larson–Miller approach for creep performance – justification for Nickel as a high-temperature material - physical metallurgy of nickel and its alloys: Composition–microstructure relationships in nickel alloys, FCC, gamma prime, gamma double prime phase, TCP phases, carbide and boride phases, grain-boundary carbides – Defects - Strengthening effects in nickel alloys: strengthening by particles of the gamma prime phase, temperature dependence of strengthening, yielding effect in gamma prime alloys - creep behavior of nickel alloys: nickel and creep strengthening in nickel alloys by solid-solution strengthening and precipitation hardening.

Molybdenum: Ferromolybdenum -production of molybdenum – properties - effect of molybdenum alloying on hot strength, corrosion resistance, and toughness – applications - TZM, TZC.

Niobium: Production of niobium - niobium alloys - niobium in steel making Ni alloys characteristics and applications

Module 4

Titanium: Basic Properties, Crystal Structure, Elastic Properties, Deformation Modes - binary phase diagram classification based on alloying elements-Basic Hardening Mechanisms: Alpha Phase, Beta Phase - Sponge Production- effect of forging temperature and forging pressure - closed die forgings - pickling of titanium - scrap recycling - closed die forging - problems in machining Titanium - shear bands - Heat treatment and microstructure obtainable - welding of titanium and defects.

Detailed discussions on Vacuum induction melting (**VIM**) - Conditions for freckle formation -

- Vacuum arc remelting (**VAR**), Control, and structure developed, melt-related defects - electroslag remelting (**ESR**), electrode quality melt-related defects - triple melting, super alloy cleanliness.

Upon completion of this course work, students should be

1. Familiar with a selection of advanced materials and related processes
2. Have a basic understanding of the scientific and technological aspects of these materials and processes
3. The ability to integrate understanding of the scientific and engineering principles underlying the four major elements: structure, properties, processing and performance related to material systems appropriate to the field

References:

1. Anderson J. C. et. al., “Material science for engineers”, Chapman & Hall.
2. American Society for Metals, “Source book of Maraging Steels”.
3. Barret C. S. and Massalski T. B., “Structure of metals”, Pergamon Press.
4. Callister William. D., “Material science and engineering”, John Wiley.
5. Dieter George E., “Mechanical metallurgy”, McGraw Hill.
6. Raghavan V., “Material science and engineering”, Prentice Hall.
7. Reed Hill E. Robert, “Physical metallurgy principles”, East West Press.
8. Richard K. Wilson (Editor), “Maraging steels - recent development and applications”, TMS Publication.
9. Roger C. Reed, “The Superalloys Fundamentals and Applications”, Cambridge university press.
10. Matthew J. Donachie, Stephen J. Donachie, Superalloys, “A Technical Guide”, ASM International.
11. Van Vlack, “Elements of material science”, Addison Wesley.
12. Westbrook J. H., “Intermetallic compounds”, John Wiley.

MMEMP 102 MANUFACTURING SYSTEMS MANAGEMENT

L	T	P	C
4	0	0	4

Module 1

Introduction: Operations strategy, system concept of production, types of production system – job shop production – batch production – mass production, process planning, make or buy decisions, specific equipment selection, process plans, process reengineering.

Facilities location: Facility location factors, location analysis techniques – location factor rating – center of gravity technique – load distance technique.

Module 2

Plant layout: Need for layout, objectives, types of layout, layout design process, layout design cycle, data collection, equipment requirement, activity analysis, REL diagram, employee requirement, development of layout - block plan, selection, specification, evaluation.

Layout design procedures: ALDEP, CORELAP and CRAFT.

Module 3

Aggregate planning: Aggregate planning strategies – heuristic method for aggregate planning.

Materials requirement planning: Objectives, master production schedule, bill of materials, MRP calculations, lot sizing in MRP - economic order quantity method - minimum cost per period method - periodic order quantity method - least unit cost method - part period balancing, Evolution from MRP to manufacturing resource planning (MRP II).

Enterprise resource planning (ERP): Overview of ERP, benefits of ERP, ERP and functional units.

Module 4

Inventory analysis and control: Definitions – inventory control systems - ABC inventory System - EOQ models for purchased parts and manufactured parts – quantity discounts – reorder point - inventory models under uncertainty.

Just in time manufacturing: Introduction, elements of JIT, pull versus push method, kanban systems.

References:

1. R. Paneerselvam, “Production and operations management”, PHI, 2010
2. Roberta S. Russell and Bernard W. Taylor III, “Operations management”, PHI, 2007
3. P. B. Mahapatra, “Operations management: a quantitative approach”, PHI, 2010

4. Francis, R. L. and White, J. A., “Facility layout and location: an analytical approach”, Prentice-Hall Inc., New Jersey, 1974.
5. Moore, J. M., “Plant layout and design”, Macmillan Company, New York, 1970.
6. Apple, J. M., “Plant layout and material handling”, John Wiley and Sons, New York.
7. Tompkins and White, “Facilities planning”, John Wiley and Sons, New York.
8. Brady, “Enterprise resource planning”, Thomson Learning, 2001
9. S. Sadagopan, “ERP: a managerial perspective”, Tata McGraw-Hill, New Delhi 1999.

MMEMP 103 COMPUTER INTERGRATED MANUFACTURING

L	T	P	C
4	0	0	4

Module 1

CAD/CAM contents and tools, Definition of CAD/CAM tools, industrial look at CAD/CAM, **CAD/CAM hardware**: Types of systems: Mainframe-based Systems, minicomputer-based systems, microcomputer-based systems, workstation-based systems, input devices, output devices: architecture of graphics system. Graphic displays: raster display, rasterization, plasma displays, LCD displays, 3 dimensional viewers. Line and circle drawing algorithms: DDA algorithm, Bresenham's line algorithm, midpoint circle algorithm, windowing, clipping: line clipping. **Transformations:** Homogeneous coordinates 2D & 3D transformations, rotation, translation and scaling, combining transformations, hardcopy printers and plotters. Hardware integration and networking: star, ring and bus LAN Configurations. CAD/CAM software graphics standards. **Basic definitions**: Data structure, data base, DBMS, database coordinate system, user interface, software modules: operating system module, graphics module, application module, programming module, communication module.

Module 2

Geometric modeling: Types and mathematical representation of curves, wire frame models, wire frame entities, curve representation, parametric representation of analytic curves: line, circles, parametric representation of synthetic curves: Bezier curves. **Types and representation of surfaces**: Surface models, surface entities, surface representation, parametric representation of analytic surfaces: ruled surfaces, surface of revolution, tabulated cylinder, parametric representation of synthetic surfaces: Bezier Surface. **Types and representation of solids:** Solid models, solid entities, solid representation, B-rep, CSG, sweep representation.

Module 3

Computer numerical control of machine tools: Principles types of CNC machine tools and their construction features – tooling for CNC – ISO designation for tooling – CNC operating systems - CNC Part Programming - detailed manual part programming on lathe & milling machines using G & M codes, programming (a typical control system), computer aided CNC part programming – generation of tool path, generation of G & M codes, optimization of tool path (to reduce machining time), - CNC part programming with CAD system - machining centers, 5 axis machining - design changes for manufacturing problems. (Features available on typical CAM software).

Module 4

Computer aided process planning: Group technology and process planning: concepts of group technology. traditional & computer aided process planning, retrieval & generative process planning, machinability data systems, computer-generated time standards, generation of route sheets, selection of optimal machining parameters, methods. **Computer process monitoring:** Process control methods, direct digital control, supervisory computer control, steady state optimal control, on line search strategies, adaptive control.

References:

1. Alavudeen & N. Venkateshwaran, “Computer integrated manufacturing”, PHI, 2005
2. Bresenham, J. E., “Ambiguities in incremental line rastering”, IEEE Computer Graphics and Applications, Vol. 7, No. 5, May 2000
3. Chris McMahon & Jimmie Browne, “CAD CAM principles, practice and manufacturing management”, Pearson Education, 2000
4. David Parrish, “Flexible manufacturing”, Butterworth - Heinemann Ltd, 2004
5. Donald Hearn & M. Pauline Baker, “Computer graphics”, Pearson Education, 2004
6. Eckland, Eric, “Improved techniques for optimising iterative decision - variable algorithms, drawing anti-aliased lines quickly and creating easy to use color charts”, CSC 462 Project Report, Department of Computer Science, North Carolina State University, Spring 1999
7. Foley, J. D. and A. Van Dam, “Fundamentals of interactive computer graphics”, Addison - Wesley 1982
8. Fu, K. S., Gonzalez, R. C. and Lee, C. S. G., “Robotics - control, sensing, vision and intelligence”, McGraw Hill
9. Ibrahim Zeid and R Sivasubramanian, “CAD/CAM theory and practice”, McGraw Hill, 2002
10. J. D. Foley, A. Van Dam, S. K. Feiner, J. F. Hughes and R. L. Phillips, “Introduction to computer graphics”, Addison Wesley, 1997
11. Koren, Yoram, “Robotics for engineers”, McGraw Hill
12. Mike Mattson, “CNC programming principles and applications”, Delmar Cengage Learning, 1999
13. Noff, Shimon Y., “Handbook of robotics”, John Wiley & Sons
14. Shirley, Peter, “Fundamentals of computer graphics”, 1st Edition, A. K. Peters Ltd., 2002

15. Schilling, Robert J., “Fundamentals of robotics, analysis & control”, Prentice Hall of India, 2004
16. Rooks B. (Editor), “Robert vision & sensory controls”, Vol.3, North Holland

MMEMP 104 QUALITY ENGINEERING AND MANAGEMENT

L	T	P	C
4	0	0	4

Module 1

Quality: Defining quality – philosophies of quality 'gurus'- dimensions of quality - measures of quality – cost of quality – direct costs & indirect costs – 'defectives' and its significance - traditional model and emerging model of 'cost-of-quality.'

Continuous process improvement: PDSA cycle – problem solving methodology

Module 2

Statistical process control: Statistical tools - control charts and use of probability distributions, process capability.

Acceptance Sampling: Lot-by-lot acceptance sampling by attributes – fundamental concepts, statistical aspects: operating characteristic curve, producer's risk and consumer's risk, AQL, LQ, AOQ, ASN, ATI – sampling plan design. Lot-by-lot acceptance sampling plan for attributes – acceptance sampling plans for continuous production – acceptance sampling plans for variables.

Module 3

Taguchi methods: Loss functions – signal-to-noise ratio - process optimization and robust product design using orthogonal arrays, parametric and tolerance design.

Quality function deployment: Concept - house of quality – QFD process.

Module 4

Total quality management (TQM): Definition - basic concepts – strategies.

Six sigma methodology: Basic concepts – DMAIC problem solving technique.

Quality system and standards: An overview of ISO 9000 and ISO 14000 series of standards

References:

1. Dale H. Besterfield, "Quality control", Person Education, New Delhi, 2006.
2. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield & Mary Besterfield, "Total quality management", Person Education, New Delhi, 2008.
3. R. Subburaj, "ISO 9000: Path to TQM", Allied Publishers Limited, New Delhi, 1997
4. Bank J., "The essence of total quality management", Prentice Hall
5. Dale B. G., "Managing quality", Prentice Hall
6. A.V. Feigenbaum, "Total quality control", McGraw Hill

7. G. L. Taguchi and Syed et. al., “Quality engineering production systems”, McGraw Hill
8. Essence of TQM John bank Prentice Hall
9. Zaidi, “SPC - concepts, methodology and tools”, Prentice Hall
10. Perry L Johnson, “ISO 9000”, McGraw Hill

MMEMP 105 – 1 METROLOGY AND COMPUTER AIDED INSPECTION

L	T	P	C
3	0	0	3

Module 1

Metrological concepts – Abbe's principle – need for high precision measurements – problems associated with high precision measurements. Standards for length measurement – shop floor standards and their calibration – light interference – method of coincidence – slip gauge calibration – measurement errors.

Module 2

Various tolerances and specifications – gauging principles – selective assembly – comparators. Angular measurements: principles and instruments. Thread measurements – surface and form metrology – flatness, roughness, waviness, roundness etc. – computer aided metrology – advantages and limitations.

Module 3

Laser metrology – applications of lasers in precision measurements – laser telemetric system – laser interferometer – speckle measurements – laser inspection – dimensional measurement techniques.

Co-ordinate measuring machine – contact and non-contact cmm – causes of errors – accuracy specifications – contact and non-contact probes.

Module 4

Calibration of CMM – measuring scales – Moiré fringes in linear grating – advantages and applications of CMM.

Machine vision system – image formation – binary and grayscale image – image histogram – histogram operations – pixel point processing and pixel group processing – image sharpening and smoothing – edge detection and enhancement.

References:

1. "Hand book of industrial metrology", ASME
2. Hume, "Metrology", McDonald
3. Sharp, "Metrology", ELBS
4. Taher, "Metrology", ELBS
5. Ted Busch, "Fundamentals of dimensional metrology", 3rd Edition, Delmar Publishers

MMEMP 105 - 2 TOOLING FOR MANUFACTURING AND AUTOMATION

L	T	P	C
3	0	0	3

Module 1

Locating methods: Methods, degrees of freedom, pins, vertical holding, radial location, diamond pins - principles of pin location – V locators - tool forces in different processes - principle of clamping: clamping types – quick action clamping, power clamping etc. - elements - work holding principle for irregular and round surfaces - rigid and elastic holding - types of work holders – work holder selection – analysis of clamping forces: strap clamp calculations, clamping force analysis of toggle and screw clamp - Indexing devices: linear indexing, rotary indexing etc.

Module 2

Drill jigs: Types - leaf jigs, box jigs, channel jigs, template jigs and indexing jigs – chip formation in drilling – types of drill bushings.

Types of fixtures: Economics of fixture - vise fixtures – types and details of milling fixtures, requirements of milling fixtures, special vice jaws - facing, straddle, gang, index, rotary and reciprocal milling fixtures - types and details of boring, slotting, broaching fixtures - types and details of lathe fixtures, chucks, face plate, collets, mandrels, etc. - types and details of grinding fixtures.

Module 3

Welding fixtures: Gas, arc and resistance welding fixtures – tooling for soldering and brazing - modern jigs, hydraulic and pneumatic fixtures - tool holding methods for numerical control - tool magazines – vibration isolated tool holders.

Calculation of tool forces in lathe, broaching, shaping and milling operation - determination of power consumption in cylindrical grinding, drilling, broaching, shaping and milling process – thrust on a drill.

Module 4

Machine tool slide ways: Different shapes – materials – hydrodynamic action - machine tool guides: wearing of guides- guide materials – stick slip motion in guides - temperature deformation of guides – liquid friction in guides – determination of pressure on guides – accuracy and wear of guides - design of guides under hydrostatic lubrication.

Vibration of machine tools: Effects of vibration – sources of vibration- single and two degree of freedom chatter theory – chatter in lathe, radial drilling, milling and grinding machines – elimination of vibration.

References:

1. Edward G. Hoffman, “Jig and fixture design”, Delmar Learning
2. Basu S. K., “Design of machine tools”, Allied publishers, Bombay, 1965
3. Boyes E. William, “Jigs & fixtures & gauges”, 1st Edition, SME, 1986
4. Donaldson, Lecain and Goold, “Tool design”, McGraw Hill, New York, 1976
5. Erik Karl Henriksen, “Jig and fixture design manual”.
6. Gopal Chandra Sen and Amitabha Bhattacharya, “Principles of machine tools”, New Central Book Agency, Calcutta, 1967
7. Henriksen E. K., “Jig and fixture design manual”, Industrial Press, New York, 1973
8. Joshi P. H., “Jigs & fixtures”, Tata McGraw Hill Pub. Co. Ltd., 1999
9. Koenigsberger F, “Design principles of metal cutting machine tools”, Macmillan
10. “Tool and manufacturing engineers handbook”, Volume 1: Machining, SME
11. “Die design handbook”, 3rd Edition, SME, 1990

MMEMP 105 - 3 **FINITE ELEMENT METHOD**

L	T	P	C
3	0	0	3

Module l

Basic concepts of FEM – a general procedure for finite element analysis, brief history of finite element method, linear spring as a finite element, elastic bar, spar/link/truss element. Strain energy, Castigliano's first theorem, minimum potential energy.

Module 2

Truss structures: The direct stiffness method – Nodal equilibrium equation, element transformation and direct assembly of global stiffness matrix, boundary conditions, constraint forces, element strain and stress, three dimensional trusses.

Flexure - elements – elementary beam theory, flexure element, flexure element stiffness matrix and element load vector, work equivalence for distributed loads, flexure element with axial loading.

Module 3

Method of weighted residuals – introduction, method of weighted residuals, the Galerikin finite element method, application of Galerikin's method to structural elements - spar element, beam element.

Interpolation function for general element formation – compatibility and completeness requirements, polynomial forms- one dimensional elements, triangular elements, rectangular elements, three dimensional elements, isoperimetric formulations, axisymmetric elements, numerical integration: Gaussian quadrature.

Module 4

Applications in solid mechanics – plane stress, plane strain – rectangular element, isoparametric formulation of plane quadrilateral element, axisymmetric stress analysis, general three dimensional stress – finite clement formulations, strain and stress computations, practical considerations. Torsion – boundary condition, torque. Introduction to FEM software.

References:

1. David V Hutton, "Fundamentals of finite element analysis", McGraw Hill
2. Daryl L. Logan, "First course in finite element method", Cengage Learning, Singapore.
3. J. N. Reddy, "An introduction to the finite element method", McGraw Hill

4. C. Zienkiwiez, “The finite element method”, McGraw Hill, New York.
5. K. H. Huebner, “The finite element method of engineers”, John Wiley & Sons, New York.
6. L. J. Segerlind, “Applied finite element analysis”, John Wily & Sons, New York.

MMEMP 105 - 4 ADVANCED POWDER METALLURGY

L	T	P	C
3	0	0	3

Module 1

Introduction: History – methods and design – advances in applications – process modeling and design. **Iron powder production**: The hoganas process – the pyron process – carbonyl vapor metallurgy – electrolytic iron – fluidized-bed reduction – water-atomized iron powders.

Module 2

Liquid phase sintering: Microstructure: typical microstructure, content angle, dihedral angle, volume traction, porosity and pore size, grain size and shape, contiguity, connectivity, neck size and shape etc.

Thermodynamics and kinetic factors: Kinetic energy, wetting, spreading, segregation, capillarity, viscous flow, solubility, interdiffusion etc.

Module 3

Initial stage processes: Solubility: solubility effects, melt formation, penetrations and fragmentation contact force - rearrangement: pore characteristics, phase diagram concepts, contact formation.

Intermediate stage processes: Solution representation, characteristic features, grain shape accommodation, densification, intergranular neck growth coalescence, pore filling.

Module 4

Final stage processes: Densification, grain growth, grain size distribution, discontinuous grain growth, inhibited grain growth, etc.

Properties of liquid phase Sintered materials: Microstructural effects on mechanical behavior, high temperature properties – thermal and electrical properties – wear and magnetic behavior – applications.

References:

1. Randall M. German, “Liquid phase sintering”, Plenum Press.
2. “Powder metal technologies and applications”, ASM Hand book, Vol. 7

MMEMP 106 - 1 **PRODUCTION SCHEDULING**

L	T	P	C
3	0	0	3

Module 1

Introduction to scheduling – objectives in scheduling - processing characteristics and constraints – performance measures. Single machine scheduling – sequencing theorems - SPT rule to minimize mean flow time, EDD rule to maximum lateness – branch and bound technique to minimize mean tardiness – assignment model. Parallel processors – minimization of makespan, mean weighted flowtime - McNaughton's algorithm, heuristic procedures.

Module 2

Flow shop scheduling – Extension of Johnsons's rule for 3 machine problem – branch and bound technique – Palmer's heuristic. Job shop scheduling – introduction to dispatching rules – SPT, FCFS, MWKR, MOPNR, LWKR, RANDOM – two jobs and m machines scheduling - Giffler and Thomson algorithm.

Module 3

Mass production management - basic idea of assembly line balancing - optimization of number of stations with given production rate - minimization of cycle time with fixed number of stations.
Line balancing algorithms - Kilbridge and Wester, rank positional weight method, COMSOAL, Moodie and Young method.

Module 4

Project scheduling – project network – AOA and AON - Gantt chart – critical path scheduling – probabilistic method for project scheduling – deployment of resources – activity time/cost trade-off analysis, resource leveling and resource allocation.

References:

1. R. Paneerselvam, "Production and operations management", Prentice-Hall, New Delhi, 2005
2. Roberta S. Russell and Bernard W. Taylor III, "Operations management", Pearson Education, Delhi, 2003
3. Kenneth R. Baker, "Introduction to sequencing and scheduling", John Wiley and Sons, 1974
4. Michael Pinedoo, "Scheduling: theory, algorithms and systems", Prentice Hall, New Delhi, 1995.
5. Wild, R., "Mass production management", John Wiley and Sons, New York.

MMEMP 106 - 2 **MAINTENANCE ENGINEERING AND MANAGEMENT**

L	T	P	C
3	0	0	3

Module 1

Maintenance mathematics - maintenance management and control: elements of effective maintenance management - maintenance project control methods - maintenance project control methods, problems- maintenance management control indices.

Module 2

Preventive maintenance (PM): Important steps for establishing a PM program - PM measures: mean preventive maintenance time, median preventive maintenance time, and maximum preventive maintenance time – different PM models - advantages and disadvantages.

Module 3

Corrective maintenance: Corrective maintenance types - corrective maintenance ensures: mean corrective maintenance time, median active corrective maintenance time, maximum active corrective maintenance time - different corrective maintenance mathematical models, problems - approximate effective failure rate equations for redundant systems with corrective maintenance, problems.

Module 4

Reliability centered maintenance: Goals and principles – components - maintenance costing: maintenance labor cost estimation, standard hourly cost estimation, man power repair cost estimation, corrective maintenance labor cost estimation, problems - maintenance material cost estimation - different maintenance cost estimation models - equipment ownership cycle maintenance cost estimation - maintenance cost - related indices - software maintenance costing - maintainability measures and functions.

References:

1. B. S. Dhillon, “Engineering maintenance”, CRC Press
2. Gopal Krishnan, “Maintenance and spare parts management”
3. S. K. Shrivastava, “Industrial maintenance management”

MMEMP 106 - 3 FINANCIAL ENGINEERING AND ECONOMICS

L	T	P	C
3	0	0	3

Module 1

Introduction: Objectives of financial management - financial decisions in a firm - agency problem - financial management in India

Time value of money - compounding and discounting techniques

Capital budgeting: Capital budgeting process - investment criteria - NPV, IRR, ARR, benefit cost ratio, payback period, accounting rate of return

Working capital management: Factors affecting working capital - management of cash and marketable securities

Receivables management

Module 2

Sources of long term finance - equity capital - preference capital - debenture capital - term loans - retained earnings - depreciation

Financial instruments

Financial institutions

Capital structure: Factors affecting - capital structure theories - net income - net operating income - MM approach - traditional approach

Dividends – forms - dividend policy – determinants - MM hypothesis - Walters model -Gordons model

Module 3

Demand theory: Utility analysis - indifference curve technique - consumers equilibrium -income effect - substitution effect - price effect

Elasticity of demand – price – income – cross - measurement of elasticity

Consumer surplus

Module 4

Theory of costs: Opportunity cost - implicit and explicit cost - short run total, average and marginal costs - cost curves - long run average cost curve

Marginal and average revenue

Market structures - perfect competition – monopoly - monopolistic competition - price and output determination – oligopoly - kinked demand curve - price leadership - collusive oligopoly

References:

1. Khan & Jain, “Financial management”, Tata McGraw Hill
2. Prasanna Chandra, “Financial management”, Tata McGraw Hill
3. James C. Van Horne, “Financial management and policy”, Prentice Hall of India
4. Brealy & Onyers, “Principles of corporate finance”, McGraw Hill
5. Paul Samuelson, “Economics”, Tata McGraw Hill
6. Ruddar Datt, “Indian economy”, S. Chand and Company Ltd.
7. K. K. Dewett, “Modern economic theory”, S. Chand and Company Ltd.

MMEMP 106 - 4 ADVANCED ENGINEERING MATHEMATICS

L	T	P	C
3	0	0	3

Module 1

Special functions: Power series solutions of ODE – Legendre's equation – Legerdre's polynomial – Frobenius method – generating function – Bessel's equation – Bessel's function – Recurrence relations and orthogonality property.

Moodule 2

Applications partial differential equations: Linear partial differential equation of second order – elliptic, parabolic, hyperbolic equations – solution of Laplace, one-dimensional heat & wave equations.

Numerical solution of partial differential equation: Finite difference method – solution of Laplace equation – solution of one-dimensional heat equation – Crank Nicholson method – solution of one-dimensional wave equation.

Module 3

Tensor analysis: Range and summation conventions – transformation of co-ordinates centra variant, covariant, mixed, metric and conjugate tensors, fundamental operations with Tensors – Christopher's symbols.

Module 4

Analysis of variance: One way and two way classification (single observation per cell) – basic principles of experimentation – role of randomization, replication, local control – basic designs – CRD, RBD, LSD.

References:

1. B. S. Grewal, "Higher engineering mathematics", Khanna Publishers, 2000
2. Michael E. Greenberg, "Advanced engineering mathematics", Pearson Education
3. Erwin Kreyszig, "Advanced engineering mathematics"
4. E. Balagurusamy, "Numerical methods", Tata McGraw Hill, 1995
5. Sokol Nikof, "Tensor analysis", John Wiley, New York, 2000
6. Richard A. Johnson, "Miller & Freund's probability & statistics for engineers", Prentice Hall of India, 2006

7. Jay L. Devore, “Probability and statistics for engineering and sciences”
8. B. S. Grewal, “Numerical methods in engineering and sciences”, Khanna Publications

MMEMP 107 **MANUFACTURING AND PRECISION ENGINEERING LABORATORY**

L	T	P	C
0	0	3	2

1. Computer aided drafting.
2. Solid modeling: part creation, surface generation and assemblies of parts.
3. Surface modeling.
4. FEM: creation of model, use of different elements, treatment of different loads and boundary conditions.
5. Determination of cutting force in turning, drilling and grinding using tool force dynamometer.
6. Study and programming of CNC production machines.
7. Study and programming of robots.
8. Study and measurements of components using CMM.
9. Surface roughness measurements using light, stylus, interference methods.
10. Metallographic studies using metallurgical microscope.
11. Determination of wear and coefficient of friction of the given specimen using pin on disc tester.
12. Study and use of laser interferometer for calibration of linear measurements.
13. Study of slip gauges – wringing – surface roughness - standards.
14. Study of surface plates, straight edges, angle plate, V-block etc - use of desiccants, corrosion preventing coatings etc.
15. Measurement of out of roundness using roundness measuring instrument - V block and dial indicator etc. - reasons for out of roundness etc.
16. Measurements of straightness using sprit level, auto collimator etc.
17. Measurement of thread parameters using three wire method etc.
18. Measurement of tool angles of single point tool using tool maker’s microscope.
19. Measurement of gear parameters using profile projector.
20. Evaluation of straightness error using autocollimator, sprit level, straight edge etc.
21. Experiments on limits and fits.
22. Study and use of ultrasonic flaw detector.

MMEMP 108 **SEMINAR- I**

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Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the first semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar.