APJ Abdul Kalam Technological University

Cluster 4: Kottayam

M. Tech Program in Mechanical Engineering
(Advanced Manufacturing & Production Management)

Scheme of Instruction & Syllabus: 2015 Admissions

Compiled By

Rajiv Gandhi Institute of Technology, Kottayam

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APJ Abdul Kalam Technological University

(Kottayam Cluster)

M. Tech Program in Mechanical Engineering

(Advanced Manufacturing and Production Management)

Scheme of Instruction

Credit requirements **:** 67 credits (22+19+14+12)
Normal Duration : Regular: 4 semesters; External Registration: 6 semesters;
Maximum duration : Regular: 6 semesters; External Registration: 7 semesters.
Courses: Core Courses: Either 4 or 3 credit courses; Elective courses: All of 3 credits

ELIGIBILITY: B.Tech/B.E in Mechanical Engineering, Metallurgy Engineering, Materials Engineering, Production Engineering, Automobile Engineering or Industrial Engineering with a minimum of 60 % Marks/Equivalent CGPA.

Allotment of credits and examination scheme:-

Semester 1 (Credits: 22)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	04 ME 6201	Advanced Engineering Materials and Processing	4-0-0	40	60	3	4
B	04 ME 6203	Manufacturing Systems Management	3-1-0	40	60	3	4
C	04 ME 6205	Computer Integrated Manufacturing	3-0-0	40	60	3	3
D	04 ME 6207	Quality Engineering and Management	3-0-0	40	60	3	3
E	04 ME 6XXX*	Elective - I	3-0-0	40	60	3	3
	04 GN 6001	Research Methodology	0-2-0	100	0	0	2
	04 ME 6291	Seminar - I	0-0-2	100	0	0	2
	04 ME 6293	Manufacturing and Precision Engineering Lab.	0-0-2	100	0	0	1
		Total	23				22

**See List of Electives-I for slot E*

List of Elective - I Courses

Exam Slot	Course No.	Course Name
E	04 ME 6209	Advanced Material Joining and Testing
E	04 ME 6211	Theory of Metal Forming
E	04 ME 6213	Micro Electro Mechanical Systems
E	04 ME 6215	Micro and Nano Manufacturing

Semester 2 (Credits: 19)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	04 ME 6202	Precision and Micromachining	3-1-0	40	60	3	4
B	04 ME 6204	Advanced Operations Research	3-0-0	40	60	3	3
C	04 ME 6206	Product Design and Development	3-0-0	40	60	3	3
D	04 ME 6XXX*	Elective - II	3-0-0	40	60	3	3
E	04 ME 6XXX^	Elective - III	3-0-0	40	60	3	3
	04 ME 6292	Mini Project	0-0-4	100	0	0	2
	04 ME 6294	Industrial Engineering and Computational laboratory	0-0-2	100	0	0	1
		Total	22				19

**See List of Electives -II for slot D* *^See List of Electives -III for slot E*

List of Elective - II Courses

Exam Slot	Course Code	Course Name
D	04 ME 6208	Tooling for Manufacturing and Automation
D	04 ME 6212	Advanced Powder Metallurgy
D	04 ME 6214	Finite Element Method
D	04 ME 6216	Metrology and Computer Aided Inspection

List of Elective - III Courses

Exam Slot	Course Code	Course Name
E	04 ME 6218	Supply Chain Management
E	04 ME 6222	Financial Engineering and Economics
E	04 ME 6224	Concurrent Engineering
E	04 ME 6226	Simulation of Manufacturing Systems

Summer Break

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
NA	04 ME 7290	Industrial Training	0-0-4	NA	NA	NA	Pass /Fail
		Total	4				0

Semester 3 (Credits: 14)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	04 ME 7XXX*	Elective - IV	3-0-0	40	60	3	3
B	04 ME 7XXX^	Elective - V	3-0-0	40	60	3	3
	04 ME 7291	Seminar - II	0-0-2	100	0	0	2
	04 ME 7293	Project (Phase - I)	0-0-12	50	0	0	6
		Total	20				14

**See List of Electives-IV for slot A* *^See List of Electives-V for slot B*

List of Elective - IV Courses

Exam Slot	Course Code	Course Name
A	04 ME 7201	Composite Materials and Manufacturing
A	04 ME 7203	Advanced Non-Conventional Machining Processes
A	04 ME 7205	Automation and Control Systems
A	04 ME 7207	Rapid Prototyping

List of Elective - V Courses

Exam Slot	Course Code	Course Name
B	04 ME 7209	Production Scheduling
B	04 ME 7211	Maintenance Engineering and Management
B	04 ME 7213	Decision Modelling
B	04 ME 7215	Advanced Engineering Mathematics

Semester 4 (Credits: 12)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	External Evaluation Marks		Credits
NA	04 ME 7294	Project (Phase -II)	0-0-21	70	30	NA	12
		Total	21				12

Total: 67 Credits

SEMESTER I

Syllabus

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6201	Advanced Engineering Materials and Processing	4-0-0:4	2015

Pre-requisites: Nil

Course 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.

Syllabus Content:

Atomic structure and bonds of materials; Crystallography and crystal structures; Mechanism of crystallization; Grain structures and strengths; Phase diagrams; Production and application of materials like Molybdenum, Niobium, Titanium, ceramics; Maraging steels; High temperature super alloys.

Course Outcome:

The student will demonstrate the ability to select the materials for various engineering applications.

Text books:

1. Callister William. D., "Material science and engineering", John Wiley
2. Anderson J. C. et. al., "Material science for engineers", Chapman & Hall

References:

1. Avner S. H., "Introduction to physical metallurgy", McGraw Hill
2. Barret C. S. and Massalski T. B., "Structure of metals", Pergamon Press
3. Dieter George E., "Mechanical metallurgy", McGraw Hill
4. Raghavan V., "Material science and engineering", Prentice Hall
5. Reed Hill E. Robert, "Physical metallurgy principles", East West Press
6. Van Vlack, "Elements of material science", Addison Wesley
7. Westbrook J. H., "Intermetallic compounds", John Wiley
8. "Source book of Maraging Steels", American Society for Metals

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6201	ADVANCED ENGINEERING MATERIALS AND PROCESSING	4-0-0:4	
MODULES		Contact Hours	Sem. Exam Marks;%
MODULE 1: **Atomic Structure**: correlation of atomic radius to strength, electron configurations - Primary bonds: classification - specific properties - bond energy, cohesive force, density, directional and non-directional, conductivity and non-conductivity, opaque, lustrous, density etc.– 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,- Secondary bonds: classification & properties – dispersion bond, polar molecule induced dipole bond, permanent dipole bond – hydrogen bond.		9	15
MODULE 2: **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 - Hall - Petch relation- significance high and low angle grain boundaries on dislocation, Polishing and etching to determine the microstructure.		9	15
FIRST INTERNAL TEST			

MODULE 3: **Crystal Imperfections** - 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**: Electron (or Hume - Rothery) compounds and Laves phase, AB_2 structures.	9	15
MODULE 4: **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-applications	9	15
SECOND INTERNAL TEST		
MODULE 5: **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. **Ceramics**: Paulings Rule–Cation anion radius ratio- AX, A_mX_p, $A_mB_mX_p$ type crystal structures – imperfections in ceramics.	10	20
MODULE 6: **Titanium:** Ti-based binary phase diagram - production of ingot - effect of forging temperature and forging pressure - closed die forgings - shear bands - pickling of titanium - Ti alloys - problems in machining Titanium - welding of titanium - Heat Treatment of Ti - properties of titanium aluminides - applications. **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, Vacuum induction melting (VIM), Vacuum Arc Remelting (VAR), Electroslag Remelting (ESR)	10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6203	Manufacturing Systems Management	3-1-0:4	2015

Pre-requisites: Nil

Course Objectives:

1. To develop the ability to apply the concepts of various manufacturing systems to solve organizational problems.
2. To learn to reduce the inefficiencies in manufacturing systems.

Syllabus Content:

Introduction to production systems, Facilities location, Plant layout, Inventory control, Modern production management tools, Aggregate planning, Master production schedule, Material requirement planning, Enterprise resource planning.

Course Outcome:

Knowledge of various manufacturing systems and methods for their implementation.

Text Books:

1. R. Paneerselvam, “Production and operations management”, PHI, 2010.
2. P. B. Mahapatra, “Operations management: A quantitative approach”, PHI, 2010.

References:

1. Roberta S. Russell and Bernard W. Taylor III, “Operations management”, PHI, 2007.
2. Francis, R. L. and White, J. A., “Facility layout and location: an analytical approach”, Prentice-Hall Inc., New Jersey, 1974.
3. Moore, J. M., “Plant layout and design”, Macmillan Company, New York, 1970.
4. Apple, J. M., “Plant layout and material handling”, John Wiley and Sons, New York.
5. Tompkins and White, “Facilities planning”, John Wiley and Sons, New York.
6. Brady, “Enterprise resource planning”, Thomson Learning, 2001.
7. S. Sadagopan, “ERP: a managerial perspective”, Tata McGraw-Hill, New Delhi 1999.

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6203	MANUFACTURING SYSTEMS MANAGEMENT	3-1-0:4	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1: **Introduction:** System concept of production, Types of production system, Process planning and design, Make or Buy decisions. **Facilities location:**Facility location factors, Location analysis techniques, Minimax location problem, Gravity location problem, Euclidean-Distance location problem		9	15
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.		9	15
FIRST INTERNAL TEST			
MODULE 3: **Inventory analysis and control:**Inventory decisions, Inventory control systems, ABC inventory System, Purchase Systems, Quantity discounts, Reorder point, Inventory models.		9	15
MODULE 4: **Modern production management tools:** Just in time manufacturing, Elements of JIT, Pull versus Push method, Kanban systems, Flexible Manufacturing System, Kaizen, Lean Manufacturing.		9	15
SECOND INTERNAL TEST			
MODULE 5: **Aggregate planning:** Aggregate planning strategies, Aggregate planning methods. **Master production schedule:** Cut and fit technique of MPS.		10	20
MODULE 6: **Materials requirement planning:** Bill of materials, MRP calculations, Lot sizing in MRP – EOQ, MCP, POQ, LUC, PPB methods, Evolution from MRP to Manufacturing Resource Planning (MRP II). **Enterprise resource planning (ERP):**Overview of ERP, Benefits of ERP, ERP and functional units.		10	20

Syllabus

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6205	Computer Integrated Manufacturing	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

1. Understand the basics of CAD/CAM, it's tools, hardware, geometric modeling etc.
2. Familiarise with CNC machines and part programming.
3. Impart the concept of computer aided process planning and computer process monitoring.

Syllabus Content:

Introduction to CAD/CAM hardwares and systems; Hardware integration and networking; Database coordinate system, user interface, software modules; Geometric modeling; CNC machine tools; Tooling for CNC; CNC Part Programming; CNC part programming with CAD system; Computer aided process planning; Computer process monitoring

Course Outcome:

The student acquires the knowledge of the concepts of computer integrated manufacturing.

Text Books:

1. Alavudeen & N. Venkateshwaran, "Computer integrated manufacturing", PHI, 2005
2. Ibrahim Zeid and R Sivasubramanian, "CAD/CAM theory and practice", McGraw Hill, 2002

References:

1. Bresenham, J. E., "Ambiguities in incremental line rastering", IEEE Computer Graphics and Applications, Vol. 7, No. 5, May 2000
2. Chris McMahon & Jimmie Browne, "CAD CAM principles, practice and manufacturing management", Pearson Education, 2000
3. David Parrish, "Flexible manufacturing", Butterworth - Heinemann Ltd, 2004
4. Donald Hearn & M. Pauline Baker, "Computer graphics", Pearson Education, 2004
5. 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 .

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6205	COMPUTER INTEGRATED MANUFACTURING	3-0-0:3	
MODULES		Contact Hours	Sem. Exam Marks;%
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.		9	15
MODULE 2: **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. **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.		9	15
FIRST INTERNAL TEST			
MODULE 3: **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.		9	15

MODULE 4: **Computer numerical control of machine tools:** Principal types of CNC machine tools and their construction features – tooling for CNC – ISO designation for tooling – CNC operating systems	9	15
SECOND INTERNAL TEST		
MODULE 5: **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).	10	20
MODULE 6: **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.	10	20

Syllabus

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6207	Quality Engineering and Management	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

1. Acquire knowledge on latest quality engineering tools and techniques.
2. Develop skills on foundations and phases of Six Sigma and TQM.
3. Understand SPC, acceptance sampling, Taguchi methods and QFD.

Syllabus Content:

Definition of quality; Philosophies of quality 'gurus'; Measures of quality; Cost of quality;Continuous process improvement; Statistical process control; Acceptance Sampling; Taguchi methods; Quality Function Deployment; Total Quality Management; Six sigma methodology; ISO 9000 and ISO 14000 series of standards.

Course Outcome:

The student will be able to apply the various concepts and tools of Quality Management in industry.

References:

Text books:

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

References:

1.R. Subburaj, "ISO 9000: Path to TQM", Allied Publishers Limited, New Delhi, 1997
2. Bank J., "The essence of total quality management", Prentice Hall
3. Dale B. G., "Managing quality", Prentice Hall
4. A.V. Feigenbaum, "Total quality control", McGraw Hill
5. G. L. Taguchi and Syed et. al., "Quality engineering production systems", McGraw Hill
6. Essence of TQM John bank Prentice Hall
7. Zaidi, "SPC - concepts, methodology and tools", Prentice Hall

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6207	QUALITY ENGINEERING AND MANAGEMENT	3-0-0:3	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1: **Quality:** Defining quality; Philosophies of quality 'gurus', Dimensions of quality, Measures of quality, Cost of quality – direct costs & indirect costs.		5	15
MODULE 2: 'Defectives' and its significance - traditional model and emerging model of 'cost-of-quality.' **Continuous process improvement:** PDSA cycle, Problem solving methodology.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Statistical process control:** Statistical tools, Control charts and use of probability distributions, process capability.		6	15
MODULE 4: **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.		6	15
SECOND INTERNAL TEST			
MODULE 5: **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.		10	20
MODULE 6: **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.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6209	Advanced Materials Joining and Testing	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. Understand the basics of materials joining.
2. Get an idea about different joining techniques and response of materials on joining.
3. Instruct destructive and non-destructive testing methods.

Syllabus:

Introduction to welding, residual stresses, weldability, fusion welding, high energy beam welding, destructive and non-destructive testing, material responses to welding.

Course Outcome:

The student will understand the concepts of advanced materials joining and testing, for various applications.

Text Books:

1. Richard L. Little, “Welding and welding technology”, 2000
2. S. W. Nadkarni, “Welding technology”

References:

1.J. F. Lacaster, “Metallurgy of welding, soldering and brazing”, Pergamon Press
2. “Welding handbooks”, American Welding Society
3. “Metal handbooks”, American Society of Metals
4. O. P. Khanna, “Text book of welding technology”, Dhanpat Rai& Sons
5. Carry, “Modern welding technology”, Prentice Hall

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6209	ADVANCED MATERIALS JOINING AND TESTING	3-0-0: 3	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1: **Introduction:** Classification – heat sources – metallurgical effect of weld. **Residual stresses**: formation and relieving – capillary and welding action – temperature range – filler material and fluxes – types of joints and welding positions		5	15
MODULE 2: **Weldability:** design, process and metallurgical consideration – testing and improvement.Conventional joining techniques: Bolting – riveting – soldering – blazing – adhesive bonding – diffusion bonding – mechanical joining.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Fusion welding:** Oxyacetylene welding – SMAW – GTAW – GMAW – FCAW – SAW – ESW. **High energy beam welding**: EBW, LBW, PAW – friction stir welding. Output parameter variation – advantages and disadvantages – applications.		6	15
MODULE 4: **Destructive tests** for welds: Introduction – need – principles – applications – destructive tests: tensile, bend, impact, hardness, fatigue, cracking, etching.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Non-destructive tests:** Visual, dye penetrants, magnetic particle, acoustics, pressure, radiographic, ultrasonic, eddy current testing		10	20
MODULE 6: **Responses of materials to welding:** Microstructural changes – distortion – defects: undercuts – overlaps – grain growth – blowholes – inclusions – segregation – lamellar tearing – porosity.		10	20

Syllabus

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6211	Theory of Metal Forming	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. Understand the basics of theory of deformation, plasticity and metal forming process.
2. Get an idea about rolling and metal working.

Syllabus:

Theory of deformation; Theory of strain; Basic theory of plasticity; Theory of metal forming process: Forging, Drawing, Extrusion, Extrusion; Sheet metal working.

Course Outcome:

Understanding of the basic concepts of Theory of metal forming**:**

Text Books:

1. Durelli, Phillip's &Tsao, "Introduction to the theory of theoretical and experimental analysis of stress & strain", McGraw Hill, 1953
2. Avitzur B., "Metal forming: processes & analysis", McGraw Hill

References:

1. Dieter George E., "Mechanical metallurgy", McGraw Hill
2. Ghosh A & A. K. Mallik, "Manufacturing science", Affiliated East-West Press, New Delhi
3. Hoffman O. and Sachs G., "Introduction to the theory of plasticity – metal forming applications", McGraw Hill
4. Johnson &Mellur, "Engineering plasticity", Van Nostrand, Reinhold Co.
5. Johnson W. &Mellur P. B., "Plasticity for mechanical engineers", D.VanNostrand Co., London
6. Mendelson, "Introduction to theory of plasticity"
7. Pearson C. E. and R. N. Perkins, "The extrusion of metals", John Wiley, NY, 1960
8. Prager W. and Hodge P. G., "Theory of plastic solids", Chapman & Hall Ltd, London 1951

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6211	THEORY OF METAL FORMING	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: **Theory of deformation: Theory of stress:** Components of stress tensor, principal areas and stresses, maximum shear stress, two dimensional stress systems, Mohr's circle for plane stress, problems.		5	15
MODULE 2: **Theory of strain:** Strain components, strain rate, stress strain relation.		9	15
FIRST INTERNAL TEST			
MODULE 3: **Basic theory of plasticity:** Assumptions in plasticity, flow conditions, Von-Mises yield criteria, geometrical representation of Tresca and Von-Mises yield criteria, Levy von Mises stress strain rate law. Slip line field theory, upper and lower bound theorems.		6	15
MODULE 4: **Theory of metal forming process: Forging:** Forging of a rectangular plate under conditions of plane strain and upper bound approach, forging of a solid disc on free body equilibrium and upper bound approaches, annulus disc upper bound approach, forging defects.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Drawing:** Drawing of solid rods through conical die, drawing of solid circular rod by upper bound approach, drawing of pipes over floating mandrel and wire drawing.		10	20
MODULE 6: **Extrusion**: Extrusion force in the plane extrusion of a rectangular blank, hydrostatic extrusion analysis, analysis of sinking of a thin walled tube, extrusion defects.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6213	Micro Electro Mechanical Systems	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. Understand the basics of Microsystems, scaling laws in miniaturization.
2. Get an idea about design and application of different types of sensors ..

Syllabus:

Science for microsystems, Mechanics for microsystems, Thermo fluid for microsystems, Scaling laws in miniaturization, Micro sensors, Micro actuation, Design of pressure sensors.

Course Outcome:

An introduction to the basic concepts of micro electro mechanical systems.

Text Books:

1. Jaeger R. C., “Introduction to microelectronic fabrication”, Wiley, 1989
2. Lawrence J. Kamm, “Understanding electro – mechanical engineering, an introduction to mechatronics”, Prentice Hall, 2000

References:

1. M. Elwenspoek, “Silicon micromachining”, Cambridge Press, 1998
`2. Marc J. Madou, “Fundamentals of micro-fabrication, the science of miniaturization”, IEEE Press
3. Marc Madou, “Fundamentals of micro fabrication”, CRC Press, 1997
4. RaiChoudhury P., “MEMS and MOEMS technology and applications”, PHI, New Delhi
5. Stephen D. Senturia, “Microsystem design”, Kluwer Academic Publishers, 2003
6. Trimmer, “Micromechanics and MEMS”, IEEE Press, 1997
7. Tai Ran Hsu, “MEMS and microsystems design and manufacture”, TMH, New Delhi

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6213	MICRO ELECTRO MECHANICAL SYSTEMS	3-0-0: 3	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1: **Science for microsystems:** Molecular theory, doping, diffusion, plasma physics and electrochemistry. **Mechanics for microsystems:** Static bending of thin plates, mechanical vibrations, thermomechanics and fracture mechanics, problems.		5	15
MODULE 2: **Thermo fluid for microsystems:** Incompressible fluid flow in microconduits, fluid flow in submicrometer – overview of heat conduction in solids, heat conduction in multilayerd thin films, heat conduction in solids in submicrometer scale.		6	15
FIRST INTERNAL TEST			
MODULE 3: **Scaling laws in miniaturization:** Scaling in geometry, rigid body dynamics, electroststic forces, electromagnetic forces, electricity, fluid mechanics and heat transfer – materials for MEMS..		6	15
MODULE 4: **Fabrication process:** Ion implantation – diffusion – oxidation - CVD: principle, structure, reactions, rate of deposition, different types of CVD, enhanced CVD – PVD: principle, structure, reactions, different types of PVD, magnetron sputtering etc.		5	15
SECOND INTERNAL TEST			
MODULE 5: **Micro sensors:** Acoustic wave, bio, chemical, optical and thermal sensors. **Micro actuation:** By thermal force, shape memory alloys, piezoelectric crystals and electrostatic forces. Micro actuators: Micro grippers, motor, valves, pumps and micro fluidics, fluid resistance in micro channels, capillary electrophoresis.		10	20
MODULE 6: **Design of pressure sensors –** design of accelerometers – design of resonant micro sensors, stress and strain in thin films etc. Micro machined amplitude modulated and waveguide optical sensors - micro machined optical pressure sensor – micro machined Bragg gratings - micro machined interferometric distance sensors - micro machined optochemical and bio sensors - micro machined nano probes.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6215	Micro and Nano Manufacturing	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To provide fundamental concepts of Characterizing etching processes in bulk micromachining, Crystallography and its effects, Photolithography, Micro and nanotechnology.
2. Understand the Carbonbased nanostructures.
3. To enable students to be more aware of Carbon nanotube production and applications.

Syllabus:

C`haracterizing etching processes in bulk micromachining, Crystallography and its effects, Photolithography, Micro and nanotechnology, Carbon nanotube production and applications.

Course Outcome:

The students will demonstrate the ability to understand the basics of micro and nano manufacturing.

Text Books:

1. N. P. Mahalik, “Micro-manufacturing and nanotechnology”, Springer.
2. Mark J. Jackson, “Micro and nano-manufacturing”, Springer.

References:

1. Jeremy Ramsden, “Micro &nano technologies”, Elsevier
2. M. Kahrizi, “Micromachining techniques for fabrication of micro, nano structures”.

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6215	MICRO AND NANO MANUFACTURING	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: **Characterizing etching processes** in bulk micromachining - microfabrication of MEMS and semiconductor devices -basics of microfabrication, integrated circuit fabrication etc.		5	15
MODULE 2: **Crystallography and its effects**, silicon as substrate and structural material, stress and strain, - crystal plane effects on etching, wet etching process, reaction phenomena, anisotropic etching, isotropic etch curves, masking for anisotropic etchants, etching control, fusion bonding of silicon on an insulator, deep reactive ion etching, fabrication of a cantilever probe, manufacture, microprocessors etc and applications- problems with etching in bulk micromachining.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Photolithography:** Principle of the soft lithography and applications -principle of microcontact printing and applications - characterizing the surface micromachining process, isolation layer, sacrificial layer, structural material, selective etching – properties, stress, stress measurement, stiction - wafer bonding: anodic and fusion, bonding.		6	15
MODULE 4: **Micro and nanotechnology**: Applications for space micropropulsion - subsystems and devices for miniaturised spacecrafts micropropulsion: microbolomete, micro FEEP, integrated cold-gas microthruster, microturbogas, pyrotechnic actuator and microvalveetc - propulsion systems: solid propellant, ADCS etc.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Carbon nanotube production and applications:** Basis of nanotechnology - structure and properties of carbon nanotubes- production of carbon nanotube: chemical vapour deposition, arc discharge, laser ablation, mechanisms of growth, purification of carbon nanotube – applications: electrical transport of carbon nanotubes for FET, Computers, nanodevices for biomedical, X-ray equipment,		10	20

nanomechanic actuator and artificial muscles, fuel cells, membrane electrode assembly, mechanical and electrical reinforcement of bipolar plates, hydrogen storage etc.		
MODULE 6: **Carbon based nanostructures:** - Structure of carbon nanotubes, Y-shaped, double helical, bamboo, hierarchical morphology - structure of fullerenes - structure of carbon nano balls- structure of carbon nano fibers - porous carbon - properties of carbon nanostructures – synthesis – potential applications of nanostructures - composite materials - nanotechnology for fuel cell applications: nanoparticles in heterogeneous catalysis, O2 electro reduction reaction on carbon- supported Pt catalysts, carbon nanotubes as catalyst supports.	10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6105	Research Methodology	0-2-0:2	2015

Pre-requisites: Nil

Course Objectives:

1. To get introduced to research philosophy and processes in general.
2. To formulate the research problem and prepare research plan
3. To apply various numerical /quantitative techniques for data analysis
4. To communicate the research findings effectively

Syllabus

Introduction to Research methodology, Concept of Research, Criteria of good research, meaning, need and types of research design, Sampling fundamentals, Probability distributions.Principles of thesis writing. Documentation and presentation tools

Course Outcome:

1. The student will be able understand research process and can formulate a research problem.
2. The student will be able to prepare a research proposal as per existing standards

Text Books:

1. Research Methodology: Methods and Techniques', by Dr. C. R. Kothari, New Age

References:

1. Research Methodology: A Step by Step Guide for Beginners' by Ranjit Kumar, SAGE PublicationsLtd; Third Edition
2. Research Methodology: An Introduction for Science & Engineering Students', by Stuart Melville and Wayne Goddard
3. Research Methodology: An Introduction' by Wayne Goddard and Stuart Melville, Juta and Company Ltd, 2004
4. Research Methodology, G.C. Ramamurthy, Dream Tech Press, New Delhi
5. Management Research Methodology' by K. N. Krishnaswamy et al, Person Education

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6105	RESEARCH METHODOLOGY	0-2-0:2	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1: Introduction to Research Methodology, Concepts of Research, Meaning and Objectives of Research, Research Process, Types of Research, Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical		5	15
MODULE 2: Criteria of Good Research, Research Problem, Selection of a problem, Techniques involved in definition of a problem, Research Proposals – Types, contents, Ethical aspects, IPR issues like patenting, copyrights.		5	15
FIRST INTERNAL TEST			
MODULE 3: Meaning, Need and Types of research design, Literature Survey and Review, Identifying gap areas from literature review, Research Design Process		5	15
MODULE 4: Sampling fundamentals, Measurement and scaling techniques, Data Collection – concept, types and methods, Design of Experiments. Probability distributions, Fundamentals of Statistical analysis, Data Analysis with Statistical Packages		5	15
SECOND INTERNAL TEST			
MODULE 5: Multivariate methods, Concepts of correlation and regression, Fundamentals of time series analysis and spectral analysis.		4	20
MODULE 6: Principles of Thesis Writing, Guidelines for writing reports & papers, Methods of giving references and appendices, Reproduction of published material, Plagiarism, Citation and acknowledgement. Documentation and presentation tools – LATEX, Microsoft Office with basic presentations skills, Use of Internet and advanced search techniques		4	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6291	Seminar I	0-0-2:2	2015

Pre-requisites: Nil

Course Objectives:

1. To assess the debating capability of the student to present a technical topic.
2. To impart training to a student to face audience and present his ideas and thus creating in him self-esteem and courage that is essential for an engineer.

COURSE PLAN

Individual students are required to choose a topic of their interest from areas related to the specialization, like: Materials, Manufacturing, Industrial Engineering, Quality Management etc., preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6293	Manufacturing and Precision Engineering Lab.	0-0-2:1	2015

Pre-requisites: Nil

Course Objectives:

1. To familiarize with different design and analysis softwares.
2. Understand the working of CNC and part programming in CNC.
3. To provide training in operations of CMM.

Experiments:

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. Study and programming of CNC production machines.
6. Study and programming of robots.
7. Study and measurements of components using CMM.
8. Surface roughness measurements using light, stylus, interference methods.
9. Metallographic studies using metallurgical microscope.
10. Determination of wear and coefficient of friction of the given specimen using pin on disc tester.
11. Study and use of laser interferometer for calibration of linear measurements.
12. Study of slip gauges – wringing – surface roughness - standards.
13. Study of surface plates, straight edges, angle plate, V-block etc - use of desiccants, corrosion preventing coatings etc.
14. Measurement of out of roundness using roundness measuring instrument - V block and dial indicator etc. - reasons for out of roundness etc.
15. Measurements of straightness using sprit level, auto collimator etc.
16. Measurement of thread parameters using three wire method etc.
17. Measurement of tool angles of single point tool using tool maker's microscope.
18. Measurement of gear parameters using profile projector.
19. Evaluation of straightness error using autocollimator, sprit level, straight edge etc.
20. Study and use of ultrasonic flaw detector.

Course Outcome:

The students will get the ability to understand different design and analysis software and get the opportunity to practice in CNC and CMM machines.

References: Manual of CNC, CMM, Design and Analysis software.

SEMESTER II

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6202	Precision and Micromachining	3-1-0: 4	2015

Pre-requisites: Nil

Course Objectives:

1. To understand the fundamental concepts of micromachining.
2. To introduce the importance of precision engineering and its applications.
3. To inspire the students with the latest trends in micromachining.

Syllabus:

Introduction to Laser beam machining, Machining Analysis, Mechanical micromachining, Micromachining tool design, Nanomachining, Advanced finishing processes, Micromachining by photonic beams, Micro-manufacturing for document security.

Course Outcome:

The student will understand the micromachining operations and its applications.

Text Books:

1. Hong Hocheng and Hung-Yin Tsai, “Advanced analysis of non-traditional machining”, Springer.
2. NitaigourPremchandMahalik, “Micromanufacturing and nanotechnology”

References:

1. Paulo Davim J, “Nontraditional machining processes”, ISBN 978-1-4471-5179-1, Springer-Verlag, London, 2013.
2. Joseph McGeough, “Micromachining of engineering materials mechanical engineering”, ISBN: 0-8247-0644-7.
3. M. Kahrizi, “Micromachining techniquess for fabrication of micro, nano structures”.
4. Mark J. Jackson, “Micro and nanomanufacturing”.

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6202	PRECISION AND MICROMACHINING	3-1-0: 4	
MODULES		Contact Hours	Sem. Exam Marks;%
MODULE 1: **Lasers basics**: Monochromaticity, coherence, directionality or collimation, brightness –focusing, shaping, pulsing, polarization etc. **Laser beam machining**: Integration of laser system for cutting operation - principles of laser material removal – detailed discussion on process analysis, absorbed laser power at the cut front, exothermic heat in reactive laser cutting - characteristics of cut front, temperature at cut front, melt film thickness, melt flow velocity, mobility of cut front- characteristics of cut surface, striation.		9	15
MODULE 2: **Laser Beam Machining Analysis :**Thermal dynamic instability, hydrodynamic instability - heat-affected zone - processing parameters, cutting speed, laser beam, polarization of beam, wavelength of laser beam, pulsed laser beam etc, gas nozzle etc - workpiece aspects for laser beam machining, workpiece thickness, workpiece materials – detailed discussion on different applications		9	15
FIRST INTERNAL TEST			
MODULE 3: **Mechanical micromachining:** microfluidic systems - theory of micromachining; micro milling force analysis, initial chip curl modeling, burr formation in micromachining. **Micromachining tool design** - high speed air turbine spindles- mechanical design of high-speed rotors, basic geometry of the rotor, rotor with fillet surfaces.		9	15
MODULE 4: **Nanomachining:** Introduction, nanometric machining, theoretical basis of nanomachining, Comparison of nanometric		9	15

machining and conventional machining- implementation - single point diamond turning. Cutting force and energy, cutting temperature, chip formation and surface generation, minimum undeformed chip thickness, critical cutting edge radius, properties of workpiece materials.		
SECOND INTERNAL TEST		
MODULE 5: **Advanced finishing processes (AFPs),** abrasive flow machining (AFM), magnetic abrasive finishing (MAF), magnetorheological finishing (MRF), magnetorheological abrasive flow finishing (MRAFF), magnetic float polishing (MFP), elastic emission machining (EEM), ion beam machining (IBM), and chemical mechanical polishing (CMP).	10	20
MODULE 6: **Micromachining by photonic beams-** excimer laser-model construction of laser dragging- numerical simulation of dragged profile methods. Micro-manufacturing for document security: Optically variable device - ODV foil microstructures-generic OVD microstructures- nano CODES.	10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6204	Advanced Operations Research	2-1-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To study the mathematical techniques for the effective solution of real world problems.
2. To formulate the problem and find its optimal solution.

Syllabus:

Linear Programming, Sensitivity Analysis, Parametric Linear Programming, Integer Programming, Goal Programming, Non-linear Programming, Dynamic Programming, Network Analysis.

Course Outcome:

Students who successfully complete this course will understand the mathematical techniques to solve the real world production problems.

Text Books:

1. R. Paneerselvam, “Operations research”, PHI, New Delhi, 2008.

References:

1. Ravindran, Phillips, Solberg, “Operations research principles and practice”, Willey & Sons, 1987.
2. Hamdy A. Taha, “Operations research”, Pearson, 2004.

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6204	ADVANCED OPERATIONS RESEARCH	2-1-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: **Linear Programming:**Problem formulation, Graphical solution, Simplex method. Artificial starting solution: Big M method, Two phase method. Dual simplex method, Duality theory and applications.		9	15
MODULE 2: **Sensitivity Analysis:** Adding new constraint, Adding new variable, Changes in Objective function coefficients, Changes in right-hand side constants of constraints.**Parametric Linear Programming:** Changes in Objective function coefficients, Changes in right-hand side constants of constraints.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Integer Programming:** Branch and Bound technique, Gomory's cutting plane method.		5	15
MODULE 4: **Goal Programming:**Goal Programming formulation, Simplex method for solving Goal Programming. **Nonlinear Programming:** Lagrangean method, Kuhn-Tucker conditions, Quadratic Programming.		7	15
SECOND INTERNAL TEST			
MODULE 5: **Dynamic Programming:**Cargo loading model, Reliability improvement model, Single machine scheduling model, Capital budgeting model.		8	20
MODULE 6: **Network Analysis:** Shortest Route Problem: Systematic method, Dijkstra's algorithm, Floyd's algorithm. Minimal Spanning Tree Problem: PRIM algorithm, Kruskal's algorithm. Maximum Flow Problem: Maximal flow algorithm.		8	20

Syllabus

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6206	Product design and development	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To introduce the importance of precision engineering and its applications.
2. To inspire the students with the latest trends in micromachining.

Syllabus:

New product development; Product planning; Customer need identification; Design for various aspects, like: strength, rigidity, vibration, wear. DFM, DFA, DFMA; Ergonomics and industrial design; Prototyping; RP systems; Virtual prototyping; Design for the environment.

Course Outcome:

Student gets familiarized with the modern techniques and methods for engineering product development.

Text Books:

1. Karl. T. Ulrich, Steven D. Eppinger, "Product design and development", Irwin McGraw Hill, 2000
2. A. C. Chitale and R. C. Gupta, "Product design and manufacturing", PHI

References:

1. Timjones Butterworth Heinmann, "New product development", Oxford, UCI, 1997
2. GeofferyBoothroyd, Peter Dewhurst and Winston Knight, "Product design for manufacture and assembly"
3. Dieter, George E., "Engineering design - a materials and processing approach", McGraw Hill, Singapore, 2000
4. Harry Peck, "Designing for manufacture", Pitman Publications, 1983
5. Fixel J., "Design for the environment", McGraw Hill, 1996
6. Kevien Otto and Kristin Wood, "Product design." Pearson Publication, 2004

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
09 ME6206	PRODUCT DESIGN AND DEVELOPMENT	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: **Product planning**: Identifying customer needs, Product specifications, Concept generation, Characteristics of successful product development Duration and cost of product development		5	15
MODULE 2: **Introduction to practical design of equipment:** Devices and machines, Various aspects of design: conceptual, manufacturing, strength, rigidity, vibration, wear, lubrication, maintenance and assembly.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Design for manufacturing:**Definition, Concurrent engineering, Effect of materials & manufacturing processes on design, Estimation of manufacturing costCost reduction of components and assembly, Impact of DFM on other factors. **Component design with machining considerations:** Design for components; Turning, Milling, Drilling and other related processes, including finish-machining operations.		6	15
MODULE 4: **Ergonomics and industrial design:** Introduction, General approach to the man-machine relationship, Workstation design, Control and displays, Shapes and sizes of various controls and displays.**Design of major controls**: Automobiles, machine tools etc.; Ergonomics and production, Ergonomics in automated systems, Expert systems for ergonomic design, Anthropometric data and its applications.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Prototyping:** Prototyping basics, Principles of prototyping, Technologies, Planning for prototypes. **Rapid prototyping:** Development of RP systems; Stereolithography,		10	20

Three dimensional printing, Selective laser sintering, Direct metal laser sintering, Selective laser melting, Electron beam melting, Virtual prototyping.		
MODULE 6: **Design for the environment:** Introduction, Environmental objectives, Global issues, Basic DFE methods, Design guidelines. **Lifecycle assessment**: Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method. **Techniques to reduce environmental impact:** Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency. Design to regulations and standards.	10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6208	Tooling for Manufacturing and Automation	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To introduce the various tooling methods in automation and manufacturing
2. To make awareness among students about various tool engineering aspects.

Syllabus:

Work holding devices; locators; clamps; Indexing devices; Drill jigs, fixtures. Welding fixtures, Calculation of tool forces; Machine tool slide ways; Vibration of machine tools;

Course Outcome:

The student will learn the basics of tool engineering in automated production systems.

Text Books:

1. Edward G. Hoffman, “Jig and fixture design”, Delmar Learning.
2. Joshi P. H., “Jigs & fixtures”, Tata McGraw Hill Pub. Co. Ltd., 1999.

References:

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

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6208	TOOLING FOR MANUFACTURING AND AUTOMATION	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
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		5	15
MODULE 2: **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.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Indexing devices:**Linear indexing, rotary indexing etc. **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.		8	15
MODULE 4: **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**: lathe, broaching, shaping and milling operation. Determination of power consumption in cylindrical grinding, drilling, broaching, shaping and milling process . Thrust		8	15

on a drill.		
SECOND INTERNAL TEST		
MODULE 5: **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.	8	20
MODULE 6: **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.	8	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6212	Advanced Powder Metallurgy	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To understand the basics of powder metallurgy.
2. To study the various powder metal technologies and its applications

Syllabus:

History, methods and design of Powder metallurgy; Iron powder production; Liquid phase sintering; Thermodynamics and kinetic factors; Process details of Powder metallurgy.

Course Outcome:

The student understands the powder metal technologies and its applications.

Text Books:

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

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6212	ADVANCED POWDER METALLURGY	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
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.		5	15
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.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Thermodynamics and kinetic factors:** Kinetic energy, Wetting, Spreading, Segregation, Capillarity, Viscous flow, Solubility, Iinter diffusion etc.		6	15
MODULE 4: **Initial stage processes:** Solubility; solubility effects, Melt formation,Penetrations and Fragmentation contact force, Rearrangement; Pore characteristics, Phase diagram concepts, Contact formation.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Intermediate stage processes**: Solution representation, Characteristic features, Grain shape accommodation, Densification, Intergranular neck growth coalescence, Pore filling.		10	20
MODULE 6: **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.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6214	Finite Element Method	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To gain knowledge about the fundamentals of finite element methods.
2. To understand the application of finite element analysis.

Syllabus:

General procedures of FEM; Minimum PE method, Castigliano's first theorem, Truss structures; Method of weighted residuals; Applications in solid mechanics; Introduction to FEM software

Course Outcome:

The student understands the basics of finite element analysis and its applications.

Text Books:

1. David V Hutton, "Fundamentals of finite element analysis", McGraw Hill.
2. K. H. Huebner, "The finite element method of engineers", John Wiley & Sons, New York

References:

1. L. J. Segerlind, "Applied finite element analysis", John Wily & Sons, New York.

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6214	FINITE ELEMENT METHOD	3-0-0: 3	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1: **Basic concepts of FEM**: A general procedure for finite element analysis, Brief history of finite element method		5	15
MODULE 2: Linear spring as a finite element, elastic bar, spar/link/truss element. Strain energy, Castigliano's first theorem, minimum potential energy.		5	15
FIRST INTERNAL TEST			
MODULE 3: **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.		6	15
MODULE 4: **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.		6	15
SECOND INTERNAL TEST			
MODULE 5: **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.		10	20
MODULE 6: **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.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6216	Metrology and Computer Aided Inspection	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To introduce the importance of precision engineering and computer aided inspection.
2. To learn the latest advancements in high precision measurements.

Syllabus:

Metrological concepts; Standards for length measurement; Tolerances and specifications; Angular measurements; Thread measurements; Laser metrology; Co-ordinate measuring machine; Machine vision system.

Course Outcome:

The student gets familiar with the various high precision measuring techniques.

Text Books:

1. “Hand book of industrial metrology”, ASME
2. Hume, “Metrology”, McDonald

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6216	METROLOGY AND COMPUTER AIDED INSPECTION	3-0-0: 3	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
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.		5	15
MODULE 2: **Various tolerances and specifications**: Gauging principles; Selective assembly, Comparators. Angular measurements: Principles and instruments.		5	15
FIRST INTERNAL TEST			
MODULE 3: Thread measurements; Surface and form metrology; Flatness, roughness, waviness, roundness etc. Computer aided metrology; Advantages and limitations.		6	15
MODULE 4: **Laser metrology**: Applications of lasers in precision measurements, Laser telemetric system, Laser interferometer, Speckle measurements, Laser inspection, Dimensional measurement techniques.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Co-ordinate measuring machine:** Contact and non-contact CMM. Causes of errors, Accuracy specifications, Contact and non-contact probes.Calibration of CMM; Measuring scales, Moiré fringes in linear grating, Advantages and applications of CMM.		10	20
MODULE 6: **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.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6218	Supply Chain Management	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To learn the fundamentals of supply chain and logistics management.
2. To stress the importance of an efficient and green supply chain.

Syllabus

Introduction to supply chain management, Demand forecasting in supply chain, Role of aggregate planning in supply chain, Supply chain inventory, Role of safety stock in supply chain, Sourcing decisions in supply chain, Transportation decisions in supply chain, Logistics

Course Outcome:

The student will learn to design and manage efficient supply chains.

Text Books:

1. Sunil Chopra and Peter Meindl, “Supply Chain Management - Strategy Planning and Operation”, PHI.
2. Handfield R. B., Nichols Jr. E. L., “Introduction to supply chain management”, Pearson Education.

References:

1. Raghuram R. and Rangaraj N., “Logistics and supply chain management”, Macmillan, 2001
2. Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E., “Designing & managing the supply chain: concepts, strategies & case studies”. 2nd Edition, Tata McGraw-Hill, 2003
3. Agarwal D. K., “A text book of logistics and supply chain management”, Macmillan, 2003

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6218	SUPPLY CHAIN MANAGEMENT	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: Introduction to supply chain management. Supply chain basics, decision phases in supply chain, supply chain flows, supply chain efficiency and responsiveness, supply chain integration, process view of a supply chain. Uncertainties in supply chain, key issues in supply chain management.		6	15
MODULE 2: Drivers of supply chain performance. Supply chain coordination, bullwhip effect. Developing relationships in the supply chain, resolving conflicts in supply chain relationships, role of information technology in supply chain.		5	15
FIRST INTERNAL TEST			
MODULE 3: Demand forecasting in supply chain:Role of forecasting in supply chain, components of a forecast, forecasting methods, estimating level, trend and seasonal factors, Holt's model, Winter's model, measures of forecast error. Role of aggregate planning in supply chain:Aggregate planning strategies, managing supply and demand in supply chain.		7	15
MODULE 4: Supply chain inventory:Role of cycle inventory in supply chain, economies of scale, lot sizing for a single product, lot sizing for multiple products, quantity discounts, trade promotions, price discrimination.		8	15
SECOND INTERNAL TEST			
MODULE 5: Role of safety stock in supply chain, determining appropriate level of safety inventory, inventory replenishment policies, measures of product availability. Sourcing decisions in supply chain:Supplier selection and contracts, design collaboration, making sourcing decisions in practice.		8	20
MODULE 6: Transportation decisions: Role of transportation in supply chain, factors affecting transportation decisions. Routing and scheduling in transportation. Logistics: Definition, logistics and SCM, international considerations, inbound logistics, internal logistics and outbound logistics. Reverse logistics, green supply chain.		8	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6222	Financial Engineering and Economics	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

1. To learn the basic concepts of financial management.
2. To get an introduction into modern economic theory

Syllabus

Objectives of financial management, Capital budgeting, working capital management, financial instruments and financial institutions, Demand theory, Theory of cost, market structure.

Course Outcome:

Students who successfully complete this course will have demonstrated an ability to understand the basic concepts of financial management. To get an introduction into modern economic theory.

Text Books:

1. Khan & Jain, “Financial management”, Tata McGraw Hill
2. Prasanna Chandra, “Financial management”, Tata McGraw Hill

References:

1. James C. Van Horne, “Financial management and policy”, Prentice Hall of India
2. Brealy & Onyers, “Principles of corporate finance”, McGraw Hill
3. Paul Samuelson, “Economics”, Tata McGraw Hill

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6222	FINANCIAL ENGINEERING AND ECONOMICS	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
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.		6	15
MODULE 2: Working capital management: Factors affecting working capital - management of cash and marketable securities, Receivables management. Sources of long term finance - equity capital - preference capital - debenture capital - term loans - retained earnings – depreciation.		6	15
FIRST INTERNAL TEST			
MODULE 3: 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.		6	15
MODULE 4: 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.		6	15
SECOND INTERNAL TEST			
MODULE 5: 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.		9	20
MODULE 6: Market structures - perfect competition – monopoly - monopolistic competition - price and output determination – oligopoly - kinked demand curve - price leadership - collusive oligopoly.		9	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6224	Concurrent Engineering	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To get an introduction into concurrent engineering.
2. To understand the technical and economic side of concurrent engineering.

Syllabus

Introduction, Basic process issues, Fabrication process, Concurrent engineering in manufacturing systems, Concurrent automated fabrication systems, Economic analysis and case studies.

Course Outcome:

The student will recognize the relevance of concurrent engineering.

References:

1. James L. Nevins and Daniel E. Whitney, “Concurrent design of products and processes”, McGraw Hill, 1989
2. David D. Bedworth, Mark R. Handerson and Philip M. Wilze, “Computer integrated design and manufacturing”, McGraw Hill, 1991

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6224	CONCURRENT ENGINEERING	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: Introduction - basic concepts - traditional vs. concurrent approach - schemes and tools of concurrent engineering - application of computers in the practice of concurrent engineering.		6	15
MODULE 2: Basic process issues: Process models - types - importance. Relation between models, specifications, technology, automation and process improvement. Fabrication processes - assembly processes - models of manufacturing, testing and inspection.		6	15
FIRST INTERNAL TEST			
MODULE 3: Concurrent engineering approach in manufacturing systems: System design procedure - features – intangibles. Assembly resource alternatives - task assignment - tools and tool changing - material handling alternatives.		6	15
MODULE 4: Concurrent automated fabrication systems: Introduction - methodology - preliminary and detailed work content analysis - alternatives - human resource considerations. "Technical - Economic" performance evaluation - concurrent assembly work station - strategic issues - technical issues - economic analysis.		8	15
SECOND INTERNAL TEST			
MODULE 5: Economic analysis of systems: Types of manufacturing cost - pro-forma, cash-flow, determining allowable investment - evaluation of investment alternatives - sensitivity analysis - effect of recycling and rework.		8	20
MODULE 6: Case studies of concurrent engineering practice: Automobile air-conditioning module - robot assembly of automobile rear-axles.		8	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6226	Simulation of manufacturing system	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

1. To learn the fundamentals of system simulation.
2. To make the students able to model and analyse manufacturing systems

Syllabus

Random number generation, System concept, System simulation, Concepts in discrete event simulation, Random number generation, Input modelling for simulation, Verification and validation of simulation models, Output analysis for a single model, Simulation modelling and analysis of manufacturing systems, Simulation software for manufacturing applications.

Course Outcome:

The student will be able to model and analyse manufacturing systems.

Text Books:

1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., "Discrete-event system simulation", Third Edition, Pearson Education, Inc., 2001
2. Gordon G., "System simulation", Prentice Hall Ltd. 1991

References:

1. Deo, N., "System simulation with digital computer", Prentice Hall of India, 1997
2. Askin R. G. and Standridge, C. R., "Modelling and analysis of manufacturing systems", John Wiley & Sons, 1993.

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 6226	SIMULATION OF MANUFACTURING SYSTEM	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: System concept: Systems and system environment, components of a system, discrete and continuous systems, systems approach to problem solving, types of system study, system analysis, system design and system postulation, system modelling, types of models. System simulation: Technique of simulation, comparison of simulation and analytical methods, types of system simulation, steps in simulation study, Monte Carlo simulation. Concepts in discrete event simulation: Event scheduling/time advance algorithm, modelling world views, simulation programming tasks, comparison and selection of simulation languages.		7	15
MODULE 2: Random number generation: Techniques for generating random numbers, linear congruential method, test for random numbers, frequency tests, run tests, tests for autocorrelation, gap test, and Poker test. Random variate generation: Inverse transformation technique, exponential, uniform, weibull, triangular, empirical-discrete and continuous distributions. Convolution method, acceptance - rejection technique.		6	15
FIRST INTERNAL TEST			
MODULE 3: Input modelling for simulation: Data collection, identifying the distribution with data, parameter estimation, goodness of fit test, Chi square, Klomogrov and Smirnov tests, selecting input model when data are not available.		7	15
MODULE 4: Verification and validation of simulation models: Verification of simulation models, calibration and validation of models, face validity, validation of model assumption, validating input-output transformation, input-output validation using historical input data.		7	15
SECOND INTERNAL TEST			
MODULE 5: Output analysis for a single model: Measures of performance and their estimation, point estimation, interval estimation, output analysis for terminating simulations and steady state simulations. Simulation modelling and analysis of manufacturing systems: Objectives, `performance measures, issues in simulation of manufacturing systems.		7	20
MODULE 6: Simulation software for manufacturing applications, simulation of job shop manufacturing systems, simulation modelling and analysis of single server and single queue systems, inventory systems and pert networks.		8	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6292	Mini Project	0-0-4:2	2015

Pre-requisites: Nil

Course Objectives:

To develop practical ability and knowledge about practical tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area.

COURSE PLAN

The student shall undergo a Mini Project of two months duration. The mini project is designed to develop practical ability and knowledge about practical tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area. Students can take up any application level/system level project pertaining to a relevant domain. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. For external projects, students should obtain prior permission after submitting the details to the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in relevant field of work. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation. Publishing the work in Conference Proceedings/ Journals with National/ International status with the consent of the guide will carry an additional weightage in the review process.

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 6294	Industrial Engineering and Computational Laboratory	0-0-2:1	2015

Pre-requisites: Nil

Course Objectives:

1. To familiarise the areas of Industrial Engineering and its application in industries.
2. To learn the use of software packages for solving Industial Engineering problems

Syllabus:

Experiments on:-

1. Method Analysis
2. Micro motion study
3. Work Measurement
4. Data Analysis and Solving optimization problems using software packages:-
   a. Excel
   b. SPSS
   c. TORA
5. Quality Control
6. Verification of central limit theorem for various populations
7. Study and construction of control charts
8. Study and construction of OC curve of a sampling plan
9. Simulation model building and conducting simulation experiments using:-
   a. MATLAB
   b. WITNESS
   c. ARENA

Course Outcome:

The student will learn the industrial engineering applications in industries.

References:

Lab manual and software.

SUMMER BREAK

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7290	Industrial Training	0-0-4: 0	2015

Pre-requisites: Nil

The student shall undergo Industrial training in an industry/company approved by the institution and under the guidance of a staff member in the concerned field. At the end of the training the student has to submit a report on the work being carried out. The objective of the training is to develop practical ability and knowledge about practical tools/techniques used to solve the actual problems in industry.

At the end of training presentation and review should be conducted which will be evaluated by a panel of examiners. A detailed report duly approved by the guide in the prescribed format should be submitted by the student evaluation.

It is a zero credit pass/fail course, and its evaluation is to be done in the third semester. The duration for the industrial training shall be 3 weeks.

SEMESTER – III

Syllabus

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7201	Composite Materials and Manufacturing	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. The structure, fabrication methods and characteristics of various composites are introduced.
2. Student is familiarized with Metal matrix composites and Ceramic matrix composites.

Syllabus:

Introduction to composite materials, matrix materials, reinforcement, Metal matrix composites (MMC), Ceramic matrix composites (CMC), Polymer matrix composites (PMC), Micromechanics of composites.

Course Outcome:

The student gets an insight into the various aspects of fabrication and application of composite materials in engineering.

Text Books:

1. ChawlaKrishana K., “Composite materials”, Springer Verlag

2. Autar K. Kaw, “Mechanics of composite materials”, CRC Press, 1999

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7201	COMPOSITE MATERIALS AND MANUFACTURING	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: **Introduction**: composite materials, types , classification **Fibers:** Introduction – glass fibers: fabrication, structure, properties and applications. **Boron fibers**: fabrication, structure, morphology, properties and application. **Carbon fibers**: different preparation methods, structural change during preparation, properties and application. **Aramid fibers**: fabrication, structure, properties and applications. Ceramic fibers: alumina and silicon carbide fibers. Metallic fibers.		5	15
MODULE 2: **Matrix materials**: Polymers and its characteristics – metals: fiber reinforcement of metals. **Ceramic matrix materials**: bonding and structure, effect of flaws on strength and common ceramic matrix materials.Interfaces: Wettability and bonding interface in composites – types of bonding at interface –Tests for interfacial strength.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Metal matrix composites (MMC):**Different fabrication methods of MMC – interface in MMC– discontinues reinforcement of MMC.Detailed discussion on mechanical properties –Applications.		6	15
MODULE 4: **Ceramic matrix composites (CMC**): Different fabrication methods of CMC – interface in CMC – detailed discussion on properties – toughness of CMC - applications.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Polymer matrix composites (PMC):** Different fabrication methods of PMC – interface in PMC – detailed discussion on properties – of PMC - applications. Carbon fiber composites: Fabrication – properties – interface.		10	20
MODULE 6: **Micromechanics of composites:** Maximum stress and strain criterion, Tsai-Hill and Tsai-Wu failure criterion (derivations) Mechanics of load transfer from matrix to fiber (description only).		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7203	Advanced Non-Conventional Machining Processes	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To introduce the various non-conventional methods and their characteristics.
2. To familiarize the application of different non-conventional methods.

Syllabus:

Introduction to advanced machining and manufacturing process, Electro Discharge Machining process, Electron beam machining, Plasma arc machining, Ultrasonic machining, Abrasive water-jet machining, Electro chemical machining, Hybrid machining

Course Outcome:

The student gets an insight into the various aspects of non-conventional machining process and their applications.

Text Books:

1. Kluwer, “A new direction in manufacturing”, Academic Publishers, London, 1997

2. Kalpakjian, “Manufacturing engineering & technology”, Addison – Wesley, 4nd Edition

REFERENCES:

1. Debitson A., “Hand book of precision engineering”

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7203	ADVANCED NON-CONVENTIONAL MACHINING PROCESSES	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: **Introduction to advanced machining and manufacturing process** - conventional and unconventional machining process. **Electro Discharge Machining process**: General principle and applications of electric discharge machining, electric discharge grinding and electric discharge wire cutting processes – power circuits for EDM, mechanics of metal removal in EDM, process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection - Wire EDM, principle, applications.		5	15
MODULE 2: **Non-conventional machining processes:** Principles, variables and applications of laser beam machining - general principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut. **Ion beam machining**, Focused ion beam machining: equipment – applications.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Electron beam machining -** generation and control of electron beam for machining, theory of electron beam machining, Mechanism of material removal in EB drilling- importance of vacuum- process parameters - effect of cutting speed, pulsed beam operation, heat affected zone.		6	15
MODULE 4: **Plasma arc machining** -application of plasma for machining - metal removal mechanism – process parameters -accuracy and surface finish and other applications of plasma in manufacturing industries. **Ultrasonic machining** - basic principles – equipment's -process variables, applications		6	15
SECOND INTERNAL TEST			
MODULE 5: **Abrasive water-jet machining** - basic principles – equipment's -process variables - mechanics of metal removal – MRR - application and limitations,**Electro chemical machining**- basic principles – equipment -process variables, applications.		10	20
MODULE 6: **Hybrid Machining:** Electro Chemical Discharge Machining (ECDM), principles, mechanism of material removal, process parameters, applications. Ultrasonic assisted EDM, principles, applications, Electro chemical discharge grinding, principles, applications).		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7205	Automation and Control Systems	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To provide a theoretical foundation of automation and control, which are the essential for modern CIM environments.
2. Familiarization with various components of automation.

Syllabus:

Automation; Automation strategies; Industrial control systems; Hardware Components for Automation and Process Control; Servomechanisms; Hydraulic systems

Course Outcome:

Student gets exposed to the various aspects of Industrial automation.

Text Books:

1. PatrikVenuvinod, Weiyuyin Ma, “Rapid prototyping”, Kluwer Academic Publishers
2. T. A. Grimm & Associates, “Users guide to rapid prototyping”, Society of Manufacturing Engineers (SME)

References:

1. Frank W. Liou, “Rapid prototyping & engineering applications”, CRC Press
2. Ali K. Kamarani, “Rapid Prototyping theory & practice”, Manufacturing System
3. J. A. McDonalds, C. J. Ryall, “Rapid prototyping - case book”, Wiley Eastern

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7205	AUTOMATION AND CONTROL SYSTEMS	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: **Automation:** Introduction to automation: definition, types of automation, strategies merits and criticism – manufacturing plants and operations. **Automation strategies** – basic elements of automated system – advanced automation functions – levels of automations – automated production lines.		5	15
MODULE 2: Economic and social issues – impact on labor. **Production automation:** Industrial control systems – process layout for automation –discrete manufacturing industries – continuous and discrete control systems.		5	15
FIRST INTERNAL TEST			
MODULE 3: **Overview of computer process control:** Fundamentals of automated assembly, parts feeding devices. Production flow analysis: general terminology and analysis. Analysis of transfer lines without storage, partial automation.		8	15
MODULE 4: **Hardware Components for Automation and Process Control**: Sensors-Actuators-Electric Motors, Other types of actuators. Analog to digital convertors-Digital to analog Convertors- Input/output devices for discrete data- Contact input/output interfaces, Pulse counters and generators.		8	15
SECOND INTERNAL TEST			
MODULE 5: **Control systems:** Servomechanisms – digital computer control – controller components. Hydraulic systems – pneumatic systems		8	20
MODULE 6: Stepper motor-transfer functions – block diagram algebra-– signal flow graphs-Feedback and non-feedback systems.		8	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7207	Rapid Prototyping	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To provide an insight into various prototyping methods.
2. Familiarization with various methods of Rapid prototyping

Syllabus:

Introduction to rapid prototyping process, Stereo lithography (SL), Selective laser sinthering (SLS), Fused deposition modeling (FDM), Rapid tooling (RT), Solid Ground Curing

Course Outcome:

The student gets an insight into the various rapid prototyping process and their applications.

Text Books:

1. PatrikVenuvinod, Weiyuyin Ma, “Rapid prototyping”, Kluwer Academic Publishers
2. T. A. Grimm & Associates, “Users guide to rapid prototyping”, Society of Manufacturing Engineers (SME)

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7207	RAPID PROTOTYPING	3-0-0: 3	
MODULES		**Contact Hours**	**Sem. Exam Marks;%**
MODULE 1: Importance of being rapid- data processing for rapid prototype (RP): CAD model preparation and data interfacing for RP.		5	15
MODULE 2: **Stereo lithography (SL)**: SL process, photo polymerization of SL resins, absorption of laser radiation by the resin, recoating.SL curing and its implications, part quality and process planning		5	15
FIRST INTERNAL TEST			
MODULE 3: **Selective laser sinthering (SLS):** principle, indirect and direct SLS, process accuracy . Selective laser cladding (SLC) - laminated object manufacturing		6	15
MODULE 4: **Fused deposition modelling (FDM)** – 3D printing and desktop processes. Shape deposition manufacturing – vacuum casting – electroforming – freeze casting – 3D welding.		6	15
SECOND INTERNAL TEST			
MODULE 5: **Rapid tooling (RT):** Classification of RT – indirect RT – applications of RP: - heterogeneous objects, assemblies, MEMS and other small objects, medicine and art.		10	20
MODULE 6: **SOLID GROUND CURING:** Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7209	Production Scheduling	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

1. To learn the fundamentals of different types of scheduling techniques.
2. To stress the importance of mass production and assembly line balancing.

Syllabus

Introduction to scheduling, Single machine scheduling, Flow shop scheduling, Job shop scheduling, Mass production management and project scheduling.

Course Outcome:

The student will learn to design and manage different types of scheduling problems.

Text Books:

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

References:

1. Kenneth R. Baker, “Introduction to sequencing and scheduling”, John Wiley and Sons, 1974
2. Michael Pinedoo, “Scheduling: theory, algorithms and systems”, Prentice Hall, New Delhi, 1995
3. Wild, R., “Mass production management”, John Wiley and Sons, New York.

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7209	PRODUCTION SCHEDULING	3-0-0: 3	
MODULES		Contact Hours	Sem. Exam Marks;%
MODULE 1: **Introduction to scheduling:** Objectives in scheduling - processing characteristics and constraints – performance measures. Loading. Sequencing. Advanced planning and scheduling systems. Employee scheduling		5	15
MODULE 2: Single machine scheduling – 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.		6	15
FIRST INTERNAL TEST			
MODULE 3: Flow shop scheduling – Extension of Johnsons's rule for 3 machine problem – branch and bound technique – Palmer's heuristic.		5	15
MODULE 4: Job shop scheduling. Introduction to dispatching rules – SPT, FCFS, MWKR, MOPNR, LWKR, RANDOM – two jobs and m machines scheduling - Giffler and Thomson algorithm.		6	15
SECOND INTERNAL TEST			
MODULE 5: 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.		10	20
MODULE 6: 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 levelling and resource allocation.		10	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7211	Maintenance Engineering and Management	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

1. To familiarize with standard maintenance management tools.
2. To make the student capable of handling maintenance management of an industry, independently

Syllabus

Maintenance and its needs, Maintenance mathematics, Preventive maintenance, Corrective maintenance, Reliability centered maintenance, Maintenance costing.

Course Outcome:

The student becomes capable of employing the right tools, for addressing the various issues of maintenance management.

Text Books:

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

References:

1. S. K. Shrivastava, “Industrial maintenance management”

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7211	MAINTENANCE ENGINEERING AND MANAGEMENT	3-0-0: 3	
MODULES		**Contact Hours**	**Sem.Exam Marks;%**
MODULE 1: Maintenance and its needs, Maintenance classification. Maintenance project control: Maintenance project control methods, problems- maintenance management control indices.		6	15
MODULE 2: Maintenance mathematics: Maintenance management and control- Elements of effective maintenance management.		6	15
FIRST INTERNAL TEST			
MODULE 3: 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.		7	15
MODULE 4: 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.		7	15
SECOND INTERNAL TEST			
MODULE 5: Reliability centered maintenance: Goals and principles – components. RCM techniques.		8	20
MODULE 6: 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.		8	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7213	Decision Modelling	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

1. To make the student capable of decision making objectively
2. To familiarize the optimization algorithms for decision making.

Syllabus

Introduction to decision making, Multi-objective decision models, Sequential decision making, Sequential decision making (stochastic case), Unconstrained optimization algorithms for decision making.

Course Outcome:

Scientific decision making, based on multi-objective models is understood by the students.

Text Books:

1. Taha H. A., “Operations research: an introduction”, Maxwell Macmillan International Edition, 1989
2. Rao, S. S., “Optimization: theory and applications”, Second Edition, Wiley Eastern, 1994.

References:

1. Budnick F. S., McLeavey and R. Mojena, “Principles of operations research for management”, 2/e, Richard D. Irwin Inc., Homewood, Illinois, 1991.
2. Hillier, F. S., and Liberman, G. J., “Introduction to operations research”, McGraw-Hill International Edition, 2001

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7213e	DECISION MODELLING	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
MODULE 1: Introduction to decision making: Decision analysis, decisions under risk, decision trees – decision analysis with experimentation, utility theory, decisions under uncertainty.		6	15
MODULE 2: Multi-objective decision models: Introduction to multi-objective decision making, concept of pareto-optimality, the weighting method of solution, analytic hierarchy process.		6	15
FIRST INTERNAL TEST			
MODULE 3: Sequential decision making (deterministic case):Sequential decision models, dynamic programming.		6	15
MODULE 4: Bellman's principle of optimality, forward recursion and backward recursion, discrete state discrete time case, continuous state continuous time case		6	15
SECOND INTERNAL TEST			
MODULE 5: Sequential decision making (stochastic case): Stochastic processes, Markov processes, Markov chains, Markov decision problems. Algorithms for solving Markov decision problems, finite- stage models, infinite stage models.		9	20
MODULE 6: Unconstrained optimization algorithms for decision making: Fibonacci search method, golden section search method. Hooke and Jeeve's method, Newton-Raphson method, Cauchy's (Steepest descent) method. Complexity of algorithms: complexity of algorithms for combinatorial optimization problems		9	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7215	Advanced Engineering Mathematics	3-0-0: 3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

1. To assist research studies in industrial management.
2. To firm up the mathematical base, for further studies in the specialization

Syllabus

Special functions, Applications partial differential equations, Numerical solution of partial differential equation, Tensor analysis, Analysis of variance, Basic principles of xperimentation

Course Outcome:

Strong mathematical base for further studies and research.

Text Books:

1. B. S. Grewal, “Higher engineering mathematics”, Khanna Publishers, 2000
2. Michael E. Greenberg, “Advanced engineering mathematics”, Pearson Education

References:

1. Erwin Kreyszig, “Advanced engineering mathematics”
2. E. Balagurusamy, “Numerical methods”, Tata McGraw Hill, 1995
3. Sokol Nikof, “Tensor analysis”, John Wiley, New York, 2000

COURSE PLAN

COURSE CODE	COURSE TITLE	CREDITS	
04 ME 7215	ADVANCED ENGINEERING MATHEMATICS	3-0-0: 3	
MODULES		Contact Hours	Sem.Exam Marks;%
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.		6	15
MODULE 2: Applications partial differential equations: Linear partial differential equation of second order –elliptic, parabolic, hyperbolic equations – solution of Laplace, one-dimensional heat & wave equations.		6	15
FIRST INTERNAL TEST			
MODULE 3: 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.		6	15
MODULE 4: Tensor analysis**:** Range and summation conventions – transformation of co-ordinates- contra variant, covariant, mixed, metric and conjugate tensors, Fundamental operations with Tensors – Christopher's symbols.		6	15
SECOND INTERNAL TEST			
MODULE 5: Analysis of variance**:** One way and two way classification (single observation per cell).		9	20
MODULE 6: Basic principles of experimentation – role of randomization, replication, local control – basic designs –CRD, RBD, LSD.		9	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7291	Seminar II	0-0-2:2	2015

Pre-requisites: Nil

Course Objectives:

1. To assess the debating capability of the student to present a technical topic of a higher level
2. To impart training to a student to face audience and present his ideas and thus creating in him self-esteem and courage that is essential for an engineer.

COURSE PLAN

Individual students are required to choose a topic of their interest from areas related to the specialization, like: Materials, Manufacturing, Industrial Engineering, Quality Management etc., preferably in-line with Seminar I and from outside the M.Tech syllabus. Presentation of seminar on that topic will be about 30 minutes. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7293	Project Phase I	0-0-12:6	2015

Pre-requisites: Nil

Course Objectives:

To enable the students to select an emerging research area in their field of specialization.

COURSE PLAN

In Master's Project Phase-I, the students are expected to select an emerging research area in the field of specialization. After conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out as Master's Project. It is mandatory that the students should refer National and International Journals and conference proceedings while selecting a topic for their thesis. He/She should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the thesis topic.

Students should submit a copy of Phase-I Project report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the thesis. The candidate should present the current status of the Project work and the assessment will be made on the basis of the work and the presentation, by a panel of internal examiners in which one will be the internal guide. The examiners should give their suggestions in writing to the students so that it should be incorporated in the Phase–II of the project.

Master's Project-1 will undergo an evaluation by a panel of examiners including at least one external examiner appointed by university and internal examiner.

SEMESTER – IV

Syllabus

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 ME 7294	Project (Phase 2)	0-0-21:12	2015

Pre-requisites: Nil

In the fourth semester, the student has to continue the project work and after successfully finishing the work, he / she has to submit a detailed bounded project report. The evaluation of M Tech Project will be carried out by a panel of examiners. The work carried out should lead to a publication in a National / International Conference or Journal. The papers received acceptance before the M.Tech evaluation will carry specific weightage.