Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

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Department of Mechanical Engineering

Proposed Course Content for

M. Tech. in Mechanical Production Engineering

From 1st Semester - 4th Semester

Finalized in BoS meeting held on 7th April, 2017

Vision

The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology for overall development of students.

Mission

Imparting quality education, looking after the holistic development of students and conducting need-based research and extension activities.

Post Graduate Attributes

The Post Graduate Attributes are the knowledge skills and attitudes which the students have at the time of post-graduation. These Post Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of engineering problems involving research.
2. **Problem analysis:** Identity, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for engineering problems involving research and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to research activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the research based engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice to research problems.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader of a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO1	To train students with in-depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of Production Engineering.
PEO2	To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.
PEO3	To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
PEO4	To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning ability for their successful professional career.

Program Outcomes

At the end of the program the student will be able to:

PO1	Acquire, demonstrate and apply advanced knowledge in the area of production engineering.
PO2	Identify problems in the field of production engineering, formulate them and solve by using advanced techniques.
PO3	Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.
PO4	Apply various numerical methods, advanced software and engineering tools to model, analyze and solve production engineering problems.
PO5	Work effectively in interdisciplinary teams for solving real life problems in the related field.
PO6	Apply engineering and scientific principles for the effective management of production systems.
PO7	Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.
PO8	Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.
PO9	Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards.
PO10	Examine critically the outcomes of one's actions and make corrective measures subsequently.

PO11	Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.
PO12	Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture (Per Week)
T:	No. of Tutorial (Per Week)
P:	No. of Practical (Per Week)
C:	Total number of credits
BSH:	Basic Science and Humanity
BSC:	Basic Sciences Course
PCC:	Program Core Course
OE:	Open Elective

DEPARTMENT OF MECHANICAL ENGINEERING
MASTER OF TECHNOLOGY
(MECHANICAL PRODUCTION ENGINEERING)

Syllabus effective from July 2017

Semester-I

Course Code	Course Name	L	T	P	C
MMF104I	Processing of Advanced Materials	03	1	--	04
MMF102	CNC Technology	03	1	--	04
MMF104E	Advanced Tool Design	03	1	--	04
MMF101 – MMF104N	Elective-I	03	--	--	03
MMF101 – MMF104N	Elective-II	03	--	-	03
BH1101	Communication Skills	02	--	-	02
MPE101	Manufacturing Engineering Laboratory (PG LAB)	--	--	03	02
	Total for Semester-I	**17**	**03**	**03**	**22**

List of Elective Courses

Elective (I &II) Semester I

Sr. No.	Course Code	Course Name
1.	MMF101	Theory of Machining
2.	MMF103	Advanced Joining Technology
3.	MMF104A	Finite Element Method
4.	MMF104B	Machine Tool Design
5.	MMF104C	Sheet Metal Engineering
6.	MMF104D	Polymer Processing Technology
7.	MMF104F	Surface Engineering
8.	MMF104G	Hydraulic, Pneumatic and Fluidic Control
9.	MMF104H	Quality Control and Reliability
10.	MMF104J	Management Information Systems
11.	MMF104K	Technology and Knowledge Management
12.	MMF104L	Manufacturing Planning and Control
13.	MMF104M	Additive Manufacturing
14.	MMF104N	Soft Computing Techniques

Semester-II

Course Code	Course Name	L	T	P	C
MMF201	Metal Forming Processes	03	1	-	04
MMF202	Casting and Moulding Technology	03	1	-	04
MMF203A – MMF203P	Elective-III	03	1	-	03
MMF203A – MMF203P	Elective- IV	03	-	-	03
MMF204A – MMF204C	Elective-V - **(Open)**	03	-	-	03
PE201	Seminar-I	--	04	-	02
PE202	Mini -Project	--	04	-	02
	Total for Semester II	**15**	**11**	**-**	**21**

List of Elective Courses

Elective (III and IV) Semester II

Sr. No.	Course Code	Course Name
1.	MMF203A	Ultra-Precision Machining
2.	MMF203B	Lean Manufacturing
3.	MMF203C	Sensors for Intelligent Manufacturing and Monitoring
4.	MMF203D	Knowledge Based Systems in Manufacturing
5.	MMF203E	World Class Manufacturing
6.	MMF203F	Robotics
7.	MMF203G	Manufacturing Automation
8.	MMF203H	Total Productive Maintenance
9.	MMF203I	Metrology and Computer Aided Inspection
10.	MMF203J	Mechatronics
11.	MMF203K	Processing and characterization Techniques
12.	MMF203L	Micro-Nano Engineering
13.	MMF203M	Modeling and Simulation
14.	MMF203N	Numerical Methods and Computational Techniques
15.	MMF203O	CAD-CAE
16.	MMF203P	Machine Learning Techniques

Elective-V (Open Elective) Semester-II

Sr. No.	Course Code	Course Name
1.	MMF204A	Research Methodology
2.	MMF204B	Design of Experiments
3.	MMF204C	Advanced Optimization Techniques

Semester-III

Course Code	Course Name	L	T	P	C
MMF301	Project Management and Intellectual Property Rights (Self Study) *	--	--	--	02
PE302	Project Stage -I	---	--	--	10
	Total for Semester III	**--**	**--**	**--**	**12**

Semester-IV

Course Code	Course Name	L	T	P	C
PE401	Project Stage-II	-	-	-	20
	Total for Semester IV	**-**	**-**	**-**	**20**

Semester-I
Processing of Advanced Materials

MMF104I	Processing of Advanced Materials	PCC	3-1-0	4 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the advanced materials and their applications
CO2	Describe the manufacturing methods for GFRP composites
CO3	Explain the manufacturing methods for MMC and CMC composites
CO4	Identify the difficulties in machining of advanced materials
CO5	Understand the application of High speed machining for advanced materials

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1			3					1
CO2	3	3	2	1			2					1
CO3	3	2	2	1			3					1
CO4	3	2	2				1					1
CO5	3	2	2	1			2					1

Detailed Syllabus:

Unit 1
- Advanced materials such as ceramics and glasses, polymers, composites, their properties and applications, non-ferrous alloys and their properties and applications, special alloys, shape memory alloys.

Unit 2
- Polymers and polymerization, structure and properties of thermoplastics and thermosets, engineering applications, property modifications, mechanical thermal behaviors, composites with polymer matrix, ceramics, glasses.

Unit 3
- Glass ceramics, fabrication methods, metal matrix and ceramic matrix composites,

Unit 4
- Machining (traditional and non-traditional) of composite materials such as MMC, GFRP, nickel alloys, refractory metals, powder metallurgy materials.

Unit 5
- Processing of polymers, fabrication of composites, processing of ceramics, super plastic forming.

Application of non-traditional machining processes such as EDM, USM, AJM, AFM, LBM, EBM.

Unit 6

- Plasma machining, high speed machining etc. to the above advanced materials with special emphasis on mechanism of material removal, characteristic features and applications in each case. Recent trends and future prospects.

TEXTS / REFERENCES:

1. ASM Handbook, Vol. 16, Machining, 9th edition, ASM Publication, Metals Park, Ohio, 1988.
2. Conference Proceedings on "Processing, Fabrication and Applications of Advanced Composites", Edited by K. Upadhya.
3. J. S. Campbell, *"Principles of Manufacturing Materials and Processes"*, McGraw-Hill, New York.
4. E. P.DeGarmo, *"Materials and processes in manufacturing"*, Collier MacMillan, New York.
5. Zehev Tadmor,*"Principles of Polymer Processing"*, Wiley-Interscience Publications.
6. Serope Kalpakjian and Steven R. Schmid, *"Manufacturing Engineering and Technology"*, Addison Wesley Longman (Singapur) Pvt. Ltd., India Branch.
7. Ghosh, A., and Mallik , A.K.," Manufacturing Science", East -West Press Private Ltd.
8. P.C. Pande, and H.S.Shah, *"Modern Machining Processes"*, Tata McGraw-Hill, New Delhi, 1980.

Semester-I

CNC Technology

MMF102	CNC Technology	PCC	3-1-0	4 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations
CO2	Write simple part programs for the two axis CNC lathe and router and milling machines
CO3	Be introduced to master cam's machining software program.
CO4	Calculate speeds and feeds for CNC machining operations and Debug a CNC part programming.
CO5	Identify cutting tools used for milling turning and wood cutting operations
CO6	Simulate part programs on CNC machining simulation software.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1						2	1		1	1	2
CO2	1	1						1			1	

CO3	1			1							1	1
CO4	1	1		1				1		1	1	
CO5	1		1				1	1		1	1	1
CO6	1	1		1			1			1	1	1

Course Contents:

Unit 1

- Introduction to Numerical Control in computer aided manufacturing, components of a CNC system, types of CNC systems, open loop and closed loop control systems.

Unit 2

- Drives and controls, interpolators, feedback devices, CNC machine constructional features.

Unit 3

- CNC design considerations, CNC turret punch press, tooling for CNC, APC, ATC, CNC machine accessories, advanced features of CNC systems.

Unit 4

- CNC part programming for turning and milling, post processors, CNC part programming with CAD-CAM.

Unit 5

- Conversational and graphics based software, solids based part programming, free form surface machining, simulation and verification of CNC programs, computer assisted part programming.

Unit 6

- Maintenance and installation of CNC systems, utilization of CNC machines.

TEXTS / REFERENCES:

1. S. Krar, A.Gill.,*CNC Technology and Programming*, McGraw-Hill Publishing Co., 1990.
2. P. J. Amic, *Computer Numerical Control Programming*, Prentice Hall, 1996.
3. K. J.Astrom, B. Wittenmark, *Adaptive Control* (2nd Ed.), Addison-Wesley, 1994.
4. D.Gibbs, T.Crandell, *CNC: An Introduction to Machining and Part Programming*, Industrial Press, 1991.
5. M. Lynch ,*Computer Numerical Control for Machining*, McGraw-Hill, 1992.
6. CNC Turning machines ACE MICROMATIC operation and programming manual.
7. CNC Milling machine HASS operation and programming manual.

Semester-I

Advanced Tool Design

MMF104E	**Advanced Tool Design**	**PCC**	**3-1-0**	**4 Credits**

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the Course the student will be able to:

CO1	Define tooling's for different types of production systems.
CO2	Understand jigs and fixture design and their elements.
CO3	Design fixture for machining, welding and inspection using forces.
CO4	Design special tooling's for advanced manufacturing.
CO5	Study cost analysis, maintenance and CAD of tools.
CO6	Apply software knowledge for design of tools.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1	1		1		1				
CO2	2	3	1	3		2		1			1	
CO3	2	3	1	3	2	2		1			1	
CO4	2	3	1	3	2	2		1			1	
CO5	2	3	2	2	2	2		1	1		1	
CO6	2	2	1	2	2	1		1			1	

Course Contents:

Unit 1

- Influence of tooling on quality and productivity, requirement of tooling for flexible, small lot production with constraints on lead time.

Unit 2

- Jigs and fixtures: basic principles of locating, development of fixture using locating, clamping, indexing tool setting elements.

Unit 3

- Force analysis- standardization of elements, illustrative examples of machining, welding, assembly, and inspection fixtures.

Unit 4

- Design of special tooling (form cutters, broaches etc.) tooling for CNC, development of modular fixtures and tools, flexi tools, etc. innovative concepts like tooling or fragile parts, plastics for tooling etc.

Unit 5

- Manufacture and maintenance of tools, technology and management of a tool room, cost estimation and cost benefit analysis, CAD of tools: customization of CADD.

Unit 6

- Tool design software, parametric programming of tool libraries, mechanistic analysis, use of finite element methods, techniques for integration of part modeling, tool design and tool manufacture.

TEXTS / REFERENCES:

1. Donaldson, Lecain&Gold, *Tool Design*, Tata McGraw-Hill, New Delhi, 1978.
2. F. W.Wilson ,*Tool Engineers Handbook*, Tata McGraw-Hill, New Delhi, 1980.
3. P. H.Joshi, *Jigs and Fixtures*, Tata McGraw-Hill, New Delhi, 1988.
4. E. G.Hoffman , *Fundamentals of Tool Design*, S. M. E. Michigan, 1984.
5. V.Korskov ,*Fundamentals of Fixtures Design*, Mir Publishers, Moscow, 1989.

Semester-I
Theory of Machining

MMF101	Theory of Machining	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering mathematics-I
Course Outcomes: At the end of the course the student will be able to:

CO1	Classify conventional and non-conventional machining processes.
CO2	Understand mechanism of metal cutting.
CO3	Determine force, stress, temperature, tool life, tool wear in metal cutting.
CO4	Identify method of cutting fluid delivery, surface integrity evaluation and minimum cost and production time in metal cutting.
CO5	Describe the mechanism and mechanics of grinding processes.
CO6	Understand mechanism, application, limitations and benefits of various non-conventional machining processes.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2	2				1				1		1
CO3	2	2	1	1	1	1				1		
CO4	2	2	1	1	1	1			1	1		
CO5	2	2	1	1	1	1						
CO6	2	2	1	1	1	1		1	1	1		1

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

- Machine Tools and machining operation: Introduction, generating motions of machine tools, machines using single point tools, machines using multipoint tools, machines using abrasive wheels, summary of machine tool characteristics and machining equations.

Unit 2

- Mechanics of Metal Cutting: Introduction, terms and definitions, chip formation, forces acting on the cutting tool and their measurement, specific cutting energy, plowing force and the "size effect", The apparent mean shear strength of the work material, chip thickness, friction in metal cutting.
- Temperature in Metal Cutting: Heat generation in metal cutting, heat transfer in moving material, temperature distribution in metal cutting, The measurement of cutting temperatures.

Unit 3

- Tool life and tool Wear: Introduction, progressive tool wear, forms of wear in metal cutting, the tool material, the work material.
- Cutting Fluid and Surface roughness: Cutting fluids, the action of coolants, the action of lubricants, application of cutting fluids, surface roughness.

Unit 4

- Economics of Metal Cutting Operation: Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, estimation of factors needed to determine optimum conditions, example off a constant-cutting-speed operation, machining at maximum efficiency, facing operations, operations with interrupted cuts, economics of various tool materials and tool designs, machinability data systems.

Unit 5

- Grinding: Introduction, The grinding wheel, effect of grinding conditions on wheel behavior, determination of the density of active grains, testing of grinding wheels, analysis of the grinding process, thermal effects in grinding, cutting fluids in grinding, grinding wheel wear, nonconventional grinding operations.

Unit 6

- Nonconventional Machining Processes: Introduction, range of nonconventional machining processes, ultrasonic machining, water-jet machining, abrasive-jet machining, chemical machining, electrochemical machining, electrolytic grinding, electrical discharge machining, wire electrical discharge machining, laser beam machining, plasma arc machining, comparative performance of cutting processes.
- Surface integrity: Effect of machining on surface/subsurface, various types of surface alterations, assessment of surface integrity, concept of engineered surfaces.

TEXTS/REFERENCES:

- G. Boothroyd and W.A. Knight, *Fundamentals of Maching and Machine Tools*, 2nd Edition, Mercell Dekker, New York, 1989.
- A. Ghosh and A.K. Mullick, *Manufacturing Science*, Affiliated East-West Press, 1985.
- J. McGeough, *Advanced Methods of Machining*, Chapman and Hall, London, 1988.

Semester-I
Advanced Joining Technology

MMF103	**Advanced Joining Technology**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Students will understand the theoretical aspects of welding technology in depth.
CO2	Students will be able to intelligently select the appropriate Modern welding process for a particular application.
CO3	Students will be able to describe the basic metallurgy of the melted and heat-affected zone of a metal or alloy
CO4	Students will be able to choose or adjust welding parameters and techniques to optimize the weldment properties.
CO5	Completion of the course successfully will lead to an international or at least a national level certification endorsing the proficiency of the student in the Course area.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	2	2	2			1		
CO2	1	2	2	2		1	1					
CO3	1	1	1	2		2	2					
CO4	1	1	2	1	2	1		2		1	1	
CO5	1	1	3	1			3		1			1

Course Contents:

Unit 1
- Introduction to metal joining processes, heat sources for joining of metals.

Unit 2
- Modern welding processes like EBW, LBW, USW, diffusion bonding etc.

Unit 3
- Pulsed current welding processes, welding of ceramics, plastics, composites, joint design and design of weldments.

Unit 4
- Metallurgy of welding, heat treatment, residual stresses and stress relief methods.

Unit 5
- Failure of welds, NDT of welds, inspection codes for weldments.

Unit 6

- Introduction to adhesive bonding, soldering and brazing.

TEXTS / REFERENCES:

1. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
2. P. T.Houldcroft , *Welding Process Technology*, Cambrige University Press, 1985.
3. M. M.Schwartz , *Metal Joining Manual*, McGraw Hill, NewYork, 1979.
4. L. P.Connur , *Welding Handbook, Vol. 1 & 2*, American Welding Society, 1989, 1990.

Semester-I
Finite Element Methods

MMF104A	Finite Element Methods	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basics principle of FE method
CO2	Identify mathematical model for solution of common problems
CO3	Solve structural , thermal problem using FE in 1D Case
CO4	Derive element stiffness matrix by different methods
CO5	Understand the formulation for 2D and 3D case
CO6	Recognize need for and engage in life long learning

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	3	3	1		1							1
CO3	2	2	1	2	2				2			1
CO4	3								2			
CO5	3	2										
CO6			1									3

Course Contents:

Unit 1

- 1-D Problems: Introduction to structural analysis and FEM, Introduction to approximate solutions and FEM, summary of linear elastic mechanics.

Unit 2

- 1-D Problems: Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

Unit 3

- 2-D Problems: Plane stress and plane strain conditions, triangular elements, constant strain triangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements.

Unit 4

- 2-D Problems: Lagrange and Serendipity shape functions, isoparametric formulation, numerical integration, modeling with isoparametric elements, requirements for convergence, patch test, nonconforming elements, reduced integration.

Unit 5

- 3-D Problems: Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements and boundary conditions.

Unit 6

- 3-D Problems: Discrete Kirchhoffs elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plates.

TEXTS / REFERENCES:

1. R. D. Cook, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, second edition, 1981.
2. C.S. Krishnamurti, "Finite element method", Tata Mc-Graw Hill Publication.
3. K.J. Bathe, "Finite Element Method and Procedures", Prentice hall, 1996.
4. Tirupathi, R., and Chandrupatla, "Finite Elements in Engineering", PHI Publication, New Delhi.
5. Bruce Irons and Soharab Ahmed, "Techniques of Finite Elements", John Wiley and Sons, New York.
6. K.J. Bathe, "Finite Element Method", Prentice Hall, 1987.
7. O.P., Goptha, "Finite and Boundary Element Methods in Engineering", Oxford and IBH.

Semester-I
Machine Tool Design

MMF104B	**Machine Tool Design**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Study kinematics of various machine tools.
CO2	Understand principles of various machine tool feed and speed drives.
CO3	Design power screws, slideways and machine tool spindle with bearings.
CO4	Design structure and other auxiliary mechanism of machine tool.
CO5	Apply modular design aesthetics and ergonomics for machine tool.
CO6	Study acceptance test of machine tools and methods of machine tool condition.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	3		1	2			1		1
CO2	2	2	1	2		1	1			1		1
CO3	2	1		2	2						1	1
CO4	2	1		2	2						1	1
CO5	2	2		1	2	2			2	2	1	1
CO6	2	2	1	2	2	1		1		1		1

Course Contents:

Unit 1
- Introduction to metal cutting machine tools- criteria for the selection of operating capacity and design parameters, kinematics of machine tools.

Unit 2
- Basic principles of machine tool design, estimation of drive power, machine tool drives, electrical, mechanical and fluid drives, stepped and step less speed arrangements and systems.

Unit 3
- Design of machine tool spindles and bearings, design of power screws, design of slide ways, selective and pre-selective mechanisms.

Unit 4
- Machine tool structures-beds, columns, tables and supports, stock feed mechanism, Measurement and control of machine tools, protective and safety devices, design of precision machine tools.

Unit 5

- Micro-feeding mechanisms, concept of modular design and integration of SPM`s, Concepts of aesthetic and ergonomics applied to machine tools.

Unit 6

- Acceptance tests standardization of machine tools, machine tool conditioning, latest trends in machine tool design, introduction to CAD techniques.

TEXTS / REFERENCES:

1. N. K.Mehta , *Machine tool design*, Tata Mcgraw-hill, New Delhi, 1989.
2. N.Acherkan, *Machine tool design*, Vol. 3 and 4, Mir publisher, Moscow, 1968.
3. A.Koenigsburger, *Design principles of metal cutting machine tools*, Pergamon press, 1964.
4. C.M.T.I. Machine tool design course notes, C.M.T.I. Bangalore.
5. G.Sen and A.Bhattacharya , *Principles of machine tools*, Vol. 2, NCB, Calcutta, 1973.

Semester-I
Sheet Metal Engineering

MMF104C	Sheet Metal Engineering	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the applications of sheet metal processes
CO2	Predict he spring back in metal forming products
CO3	Understand the presses used in metal forming
CO4	Describe the computer aided metal forming
CO5	Draw the forming limiting diagrams

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1							1
CO2	3	3	1	1	1							1
CO3	3	3	2	1	1							1
CO4	1	1	1	2	3							1
CO5	1	1	1	4								1

Course Contents:

Unit 1
- Production of high quality sheet metal and control of its properties during processing.

Unit 2
- Basic applications: shearing processes like blanking, piercing, and punching.

Unit 3
- Drawing processes like shallow and deep drawing of cylindrical and rectangular bodies forming and bending including estimation and control of spring back.

Unit 4
- Computer applications in sheet metal with particular reference to nesting, tool selection and process planning, die design with special reference to compound and progressive dies.

Unit 5
- Equipment for sheet metal working: mechanical and hydraulic presses, design features and force diagrams.

Unit 6
- Formability studies: forming limit diagrams, their creation and use, soft tool processes: hydro-forming analysis and applications.

TEXTS / REFERENCES:

1. D. Eary and E. Reed, *Techniques of Press Working*, Prentice Hall, 1989.
2. Die Design Handbook, ASTME, 1989.
3. A. S. Deshpande, *Sheet Metal Engineering*, 1999.
4. ASM Handbook (10th edition) Vol. 15 on Metal Forming, ASM Publication, Metals Park, Ohio, 1989.
5. C. W.Hinman , *Press Working of Metals*, McGraw Hill, NY, 1980.
6. J. A.Waller, *Press Tools and Press Work*, Porttoculis Press, 1978.

Semester-I
Polymer Processing Technology

MMF104D	Polymer Processing Technology	Elective	3-0-0	3 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Classify various plastics and polymers for product design.
CO2	Select suitable polymer using design requirements and mould flow analysis
CO3	Understand plastics moulding mechanism in injection, blow, transfer, compression methods.
CO4	Study plastics sheet and film manufacturing using extension and machining and joining methods.
CO5	Explain bending and forming of plastics part using unconventional processes
CO6	Identify various testing methods and finishing and decoration of polymer parts.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2	2		1						
CO2	2	1		1	1	1			1	1	1	1
CO3	2	1	1	2	1	1						
CO4	2	1	1	2	1	1						
CO5	2	1		1		1						
CO6	2	3	1	1	2	1			2	1	1	1

Course Contents:

Unit 1

- Properties of polymers: Physical, chemical, electrical and mechanical properties of plastics, thermal properties- types of plastics, thermosets and elastomers.
- Additives, fillers and reinforcement materials, liquid crystal polymers, engineering and mechanical plastics.

Unit 2

- Design of products: selection of plastics based on product requirement-reinforcing methods, aesthetic design, Stress strain in plastic components, design limitations-CAD/CAM application in product design by modeling, mold flow analysis .

Unit 3

- Molding of components: design of moulds, selection of material mould design for compression, injection and blow molding.
- Design of runner gate nozzle and cores, transfer molding coloring, texturing, rotational molding and casing of thermosets plastic molding machine injection, compression and blow molding machines.

Unit 4

- Extrusion of plastics: Design of extrude screw-barrel break plate die profile design pooling and take off equipment, PPE, sheet and film manufacture, thermoforming and thermoforming processes, Packaging applications

- Machining and joining of plastics: Machining of plastics by turning, drilling, milling and cutting parameters.

Unit 5

- Bending and forming of plastic components, jigs used, joining of plastics-adhesives, Solvents-cements-elastomeric cements, thermosetting adhesives, hot gas welding, spin welding and induction welding
- Unconventional processing methods: ultrasonic welding, ultrasonic assembly, ultrasonic stacking, heat sealing, thermal heat sealing and dielectric sealing, testing and quality control: melt index test, spiral flow test, volume change test, differential scanning calorometry.

Unit 6

- Thermo gravimetric analysis, thermo mechanical analysis, radiography, liquid penetrates, acoustics, photo elastic stress analysis.
- Finishing and decoration of plastic products: surface appearance, surface modification, washing, solvent cleaning and etching, chemical etching, screen printing, ink printing, laser marking, dying embossing and surface texturing, grinding and polishing.

TEXTS / REFERENCES:

1. W. J.Patton, *Plastic Technology: Theory design and Manufacture,*Tharaporwala and sons, 1981.
2. Laszlosor, *Plastic mould and dies,*Van Nostrand,1981.
3. V. Dominick ,V. Rosato, *Plastic processing, Data hand book*, Van Nostrrand, 1990.
4. A. W.Birley , *Plastic Materials*, Leonard Hill 1982.
5. S. S.Middleman , *Fundamental of polymer processing*, McGraw Hill 1977.
6. Donstatus, *Plastic finishing and decorating*, Van Nostrand, 1986.
7. Ronald, *Plastic product design,* Van Nostrand, 1970.

Semester-I
Surface Engineering

MMF104F	Surface Engineering	Elective	3-0-0	3 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Learn the importance and need of surface engineering
CO2	Describe various surface cleaning and modification techniques
CO3	Understand the concepts of surface integrity
CO4	Compare various surface coating technologies
CO5	Select appropriate method of coating for a given application
CO6	Apply measurement techniques and carry out characterization of coated surfaces.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1							1		2
CO2	2				2							
CO3	2	2	1	2						1		1
CO4	2				1			1		1		
CO5	2	2	1		1			1	1	1	1	
CO6	2	2	1	2	2			1	1	1		

Course Contents:

Unit 1

- **Introduction**
  Definition, Significance, Role of surface Engineering in creating high performance product, Functional characteristics of a surface, Nature of surfaces: Deformed layer, Beilby layer, chemically reacted layer, Physisorbed layer, Chemisorbed layer; Classification of Surface Engineering Techniques

Unit 2

- **Surface Preparation Techniques**
  Factors affecting selection of cleaning process, Significance of surface preparation, Classification of cleaning processes, Chemical cleaning processes; Mechanical Processes; Substrate considerations, Surface contaminants or soils: Various types and their removal, Tests for cleanliness.

Unit 3

- **Surface Integrity**
  Definition, Importance, Surface alterations, Factors in Surface Integrity: Visual, Dimensional Residual stress, Tribological, Metallurgical; Measuring Surface Integrity effects: Minimum and Standard data set, Macroscopic and microscopic examination.

Unit 4

- **Surface Modification Techniques**
  Classification, Thermal treatments: Laser and electron beam hardening, Mechanical treatments: Short peening : Peening action, surface coverage and peening intensity, Types and sizes of media, Control of process variables, equipment; Ion Implantation: Basic Principle, Advantages and disadvantages, equipment.

Unit 5

- **Surface Coating Techniques**
  Thermal Spraying: Types and applications; Chemical Vapour Deposition: Principles, Reactions, Types and applications; Physical Vapour Deposition: Basic principle, Evaporation, Sputtering, Ion Plating, Applications; Electroplating: Principle of working and applications; Types of Coatings: Hard, Soft, Single layer, Multi-layer.

Unit 6

- **Characterization of Coatings**

Physical characteristics and their measurements: Coating thickness, Surface Morphology and Microstructure. Mechanical properties and their Measurements: Hardness, Adhesion, Friction and Wear.

TEXT/REFERENCES:

1. ASM Handbook, Volume 5: Surface Engineering, ASM International
2. Budinski K. G.; Surface Engineering for Wear Resistance; Prentice Hall
3. Burakowski T. and T. Wierschon; Surface Engineering of Metals: Principles, Equipment, Technologies; CRC Press
4. Bhushan B. and Gupta B. K.; Handbook of Tribology: Materials, Coatings, and Surface Treatments; McGraw Hill
5. ASM Handbook, Volume 16: Machining, ASM International

Semester-I
Hydraulic, Pneumatic and Fluidic Control

MMF104G	**Hydraulic, Pneumatic and Fluidic Control**	**Elective**	**3-0-0**	**3 Credits**

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the type of control system and their utility
CO2	Describe the hydraulic power generation
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Discuss steady state operating forces, transient forces and valve instability
CO5	Design of pure fluid digital elements, Lumped and distributed parameter fluid systems

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		2							1
CO2	3	2			3	3						1
CO3	1	1		3	3	2						1
CO4	3	3	1	1	3							1
CO5	3			3	3	2						1

Course Contents:

Unit 1

- Introduction to control system, types of control system and their utility.

Unit 2

- Hydraulic power generation and transmission, valve control pressure flow relationship and constructions.

Unit 3

- Steady state operating forces, transient forces and valve instability.

Unit 4

- Circuit design, pneumatic valves, hydraulic and pneumatic drives, introduction to fluidic devices and sensors, servo hydraulics.

Unit 5

- Lumped and distributed parameter fluid systems, fluid mechanics of jets, wall attachment and vortex devices.

Unit 6

- Pure fluidic analog amplifiers, analog signal control techniques, design of pure fluid digital elements. Maintenance and trouble shooting.

TEXTS / REFERENCES:

1. J.F.Blackburn, G.Rechthof, J.L. Shearer, *Fluid Power Control*, MIT.
2. B.W.Anderson, *The Analysis and Design of Pneumatic Systems*, Wiley.
3. K.Foster, G.Parker, *Fluidic Components and Circuits*, Wiley.
4. A.B.Goodwin, *Fluid Power Systems*, Macmillan.

Semester-I
Quality Control and Reliability

MMF104H	Quality Control and Reliability	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Study various approaches of quality
CO2	Understand kaizen, Deming and Juran's quality control policies.
CO3	Study design of experiments using factorial approach and analyze the experiments.
CO4	Discuss various quality improvement processes using charts, block diagram, distribution and QFD.
CO5	Understand statistical processes control in quality and reliability assessment of product.
CO6	Understand and apply Taguchi's experimental design for quality control.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1	1	2	2	3	3	3

CO2	2	2		2		1					1	1
CO3	2	2	2	2	2	1	1	1	1	1	2	1
CO4	2	2	2	2	2	2	1	1	1	3	2	2
CO5	2	2	2	2	2	2	1	1	1	3	2	2
CO6	2											

Course Contents:

Unit 1

- Introduction: New culture of TQM, TQM axioms, consequences of total quality managing, cost of total quality, valuable tools for quality, the Japanese factor.
- The Deming Approach to management: Historical background, Deming's fourteen points for management, deadly sins & diseases, implementing the Deming's philosophy, Deming on management.
- Juran on Quality: Developing a habit of quality, Juran`s quality trilogy, the universal breakthrough sequence, JuranVs Deming.

Unit 2

- Crosby & the Quality Treatment: Crosby diagnosis of a troubled company, Crosby's quality vaccine, Crosby's absolutes for quality management, Crosby's fourteen steps for quality improvement.
- Imai`s Kaizen: The concept, Kaizen & innovation, the Kaizen management practices, Kaizen & Deming.

Unit 3

- Basic Techniques for Statistical Analysis: Introduction, measures of central tendency & dispersion, confidence intervals, hypothesis testing, frequency distributions & histograms, probability distributions, measuring linear associations.
- Design & Analysis of Experiments: Introductions, factorial experiments, aliasing, constructing fractional designs, analysis of variance.

Unit 4

- Supporting of Quality Improvement Processes: Affinity diagram, bar chart, block diagram brain storming, cause and effect analysis, control charts, cost benefit analysis, customer-supplier relationship check list, decision analysis, flow charts, force field analysis, line graph/run charts, pareto analysis, quality costing, quality function development (QFD), quality project approach & problem solving process, risk analysis scatter diagrams, Weibull analysis, 6 Sigma.

Unit 5

- Statistical Process Control: Introduction, data collection plan, variables charts, attributes, interpreting the control charts.
- Taguchi's Approach to Experimental Design & Offline Quality Control: Introduction, background to the method, Taguchi's recommended design techniques, from Deming to Taguchi & vice-versa.

Unit 6

- Reliability: Introduction, life cycle curves & probability distribution in modeling reliability, system reliability, operating characteristic curves, reliability and life testing plans.

TEXTS / REFERENCES:

1. N.Logothetis, *Managing for Total Quality From Deming to Taguchi and SPC* , Prentice Hall of India, New Delhi, 2005.
2. R.F.Lochner&J.E.Matar, *Designing for Quality*, Chapman & Hall, 2001.
3. A.Mitra , *Fundamental of Quality Control & Improvement* , Prentice Hall of India, New Delhi, 2nd edition, 2003.
4. A. Zaidi, *SPC:Concepts, Methodologies and Tools*, Prentice Hall of India, New Delhi, 1995.

Semester-I
Management Information Systems

MMF104J	Management Information Systems	Elective	3-0-0	3 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1		3	2				1				2	1
CO2	3	3	2	2	2		2				2	1
CO3	3	3	2	2	2		1				2	1
CO4		2	1				1	3			2	1
CO5		3	2	1			1		3		2	1

Course Contents:

Unit 1

- Organization and Information Systems, Foundation Concepts, Information Systems in Business, The Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for

Strategic Advantage. Changing Environment and its impact on Business, Kinds of Information Systems.

Unit 2

- Computer Fundamentals, Computer Hardware, Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources

Unit 3

- Telecommunication and Networks, Telecommunications and Networks, The Networked Enterprise, Telecommunications Network Alternatives

Unit 4

- System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems.

Unit 5

- Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Unit 6

- Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology

TEXTS / REFERENCES

1. Kenneth J Laudon, Jane P. Laudon, *Management Information Systems,* 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, *Management Information Systems,* 3rd Edition, TMH, 2004.

Semester-I
Technology and Knowledge Management

MMF104K	Technology and Knowledge Management	Elective	3-0-0	3 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Define knowledge edge and classify drivers of knowledge management.
CO2	Study the process of conversion from information to knowledge.
CO3	Understand the different phases of knowledge management.
CO4	Study different strategies to achieve successful knowledge management system.
CO5	Explain infrastructural need and different layers for knowledge management.
CO6	Study the measuring process of knowledge growth and failure and creating the knowledge management blue print.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1			3					1
CO2	3	3	2	1			2					1
CO3	3	2	2	1			3					1
CO4	3	2	2				1					1
CO5	3	2	2	1			2					1

Course Contents:

Unit 1

- Introduction: Knowledge & necessity of Knowledge, KM's value proposition, behind the buzz, assumptions about your company.
- The Knowledge Edge: A common theme, intellectual capital, knowledge, market value, and prosperity, the 24 drivers of KM, knowledge centric drivers, technology drivers, organizational structure based, drivers, personnel focused drivers, process drivers, economic drivers, creating the knowledge edge.

Unit 2

- From Information to Knowledge: From data to information to knowledge, from data to knowledge, classifying knowledge, the three fundamental steps, knowledge management systems and existing technology, taming the tiger's tail, business and knowledge.

Unit 3

- The 10-Step Knowledge Management Road Map: The 10 step knowledge management road map, phase1: infrastructural evaluation, phase2: knowledge management system analysis, design, and development, phase3: deployment, phase4: matrices for performance evaluation.

Unit 4

- The Leveraged Infrastructure: The approach leverage, leverage , leverage, leveraging the internet, enabling technologies for the knowledge management, technology framework, knowledge server.
- Aligning Knowledge management and Business Strategy: From strategic programming to strategic planning, codification or personalization, knowledge maps to link knowledge to strategy, strategic imperatives for a successful km system, assessing focus.

Unit 5

- Infrastructural Foundations: Technology components of the km architecture, the seven-layer km system architecture, foundation for the interface layer, the web or notes?, collaborative intelligence and filtering layer, audit knowledge.
- Knowledge Audit and Analysis: Measuring knowledge growth, the knowledge audit team, choosing your company's k-spots, sources of expertise, team composition and selection criteria, team life span and sizing issues, the knowledge management project leader, the km team's project space, points of failure.

Unit 6

- Creating Knowledge Management Blueprint: Analyzing lost opportunities, the knowledge management architecture, components of a knowledge management system, designing integrative and interactive knowledge applications, interoperability considerations, performance and scalability, user interface design consideration, a network view of the km architecture, future-proofing the knowledge management system

TEXTS / REFERENCES:

1. Amrit Tiwana, *The Knowledge Management Tool Kit*, Pearson Education Asia Pte. Ltd., 2000.
2. T.H.Davenport and Laurence, Prusak, *Working Knowledge: How Organizations Manage what they Know*, Harvard Business School Press, Boston, 1998.
3. I.Nonaka and H.Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press, New York, 1995.
4. IGNOU, Technology Management, 6 booklets viz. Block I to VI, IGNOU Publication No. MS-94, 1997.
5. J.B.Quinn, *Intelligent Enterprise: A Knowledge and Service-Based Paradigm for Industry*, Free Press, New York, 1992.
6. Betz Frederic, *Strategic Technology Management*, McGraw Hill, Inc., New York, 1993.

Semester-I

Manufacturing Planning and Control

MMF104L	**Manufacturing Planning and Control**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Basic mechanical engineering, Engineering graphics

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply the systems concept for the design of production and service systems.
CO2	Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.
CO3	Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.
CO4	Understand the importance and function of inventory and to be able to apply selected

	techniques for its control and management under dependent and independent demand circumstances.
CO5	Understand the lot sizing and production scheduling.
CO6	Study about quality planning, cost planning and control.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2									1		
CO2	2	1		1	2		1	2				
CO3	2				2		1	2				
CO4	2				2		2	2				
CO5	2			1	1	1	1	2				
CO6	2				3	1	1	3				

Course Contents:

Unit 1

- Overview of manufacturing systems and various issues of interest: assembly line, repetitive batch manufacturing.

Unit 2

- Cellular manufacturing, FMS, JIT, CIM, preplanning: forecasting, economic analysis, aggregate planning, capacity planning, inventory planning.

Unit 3

- Decision making in design of manufacturing systems: group technology, line balancing, plant layout.

Unit 4

- Operations planning: MRP, MRP II, hierarchical planning systems, JIT systems.

Unit 5

- FMS Operation and control: lot sizing decisions, production scheduling, line of balance .

Unit 6

- Quality planning and control, cost planning and control, Simulation analysis of manufacturing systems, case studies.

TEXTS / REFERENCES:

1. D.D.Bedworth and J.E Bailey, *Integrated Production Control, System-management, Analysis and Design*, John Wiley, 1983.

2. E.A.Elsayed and T.O.Boucher , *Analysis and Control of Production Systems*, Prentice Hall, 1985.
3. J. R.King ,*Production Planning and Control*, Pergamon Press, Oxford, 1975.
4. P.F.Bestwick and K.Lockyer, *Quantitative Production Management*, Pitman Publications, 1982.
5. A.C.Hax and D.Candea, *Production and Inventory Management*, Prentice-Hall, 1984
6. M.G.Korgaokar, *JIT Manufacturing*, Macmillan, 1992.

Semester-I
Additive Manufacturing

MMF104M	Additive Manufacturing	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the importance of Additive Manufacturing
CO2	Classify the different AM processes
CO3	Design for AM processes
CO4	Understand the applications of AM
CO5	Apply the AM Processes bio-medical applications

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	2					1
CO2	2	2	3	3	3	3	1					1
CO3	2	2	3	3	3		2					1
CO4	3	3	3	2	2	2	2					1
CO5	2	3	3	2	2	2	2					1

Course Contents:

Unit 1

- **Introduction**
  Overview - Historical Development - Need – Classification - Additive Manufacturing Technology in product development – Materials for Additive Manufacturing Technology – Traditional v/s Additive Manufacturing – Tooling – Benefits and Applications.

Unit 2

- **Geometric Model & Reverse Engineering**
  Basic Concept – Digitization Techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology, CAD model preparation – Interface Formats - Part Orientation and support generation – Model Slicing – Tool path generation – Software for Additive Manufacturing Technology: RP software.

Unit 3

- **Liquid Based and Solid Based Additive Manufacturing Systems**
  Classification – Liquid based system – Stereolithography Apparatus (SLA) – Principle, process, advantages and applications – Solid based system – Fused Deposition Modeling – Principle, process, advantages and applications, Laminated Object Manufacturing.

Unit 4

- **Powder Based Additive Manufacturing Systems**
  Selective Laser Sintering(SLS) – Principle, process, advantages and applications – Three Dimensional Printing – Principle, process, advantages and applications – Laser Engineered Net Shaping (LENS), Electron Beam Melting – Shape deposition manufacturing, Laser deposition, Lamination, Electro-optical sintering.

Unit 5

- **Rapid Casting and Segmental Object Manufacturing, Visible Slicing Implementation**
  Rapid casting using wax patterns, acrylic patterns, dense polystyrene patterns - Expanded polystyrene process – Rapid manufacturing of metallic objects.

Unit 6

- **Medical and Bio-Additive Manufacturing**
  Customized implants and prosthesis, Design and production, Bio-Additive Manufacturing – Computer Aided Tissue Engineering (CATE) – Case Studies.

TEXT/REFERENCES:

1. Chua C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid Prototyping", Hanser Gardener Publications, 2003.
3. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2007.

Semester-I
Soft Computing Techniques

MMF104N	**Soft Computing Techniques**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Classify different optimization and evolutionary algorithms.
CO2	Apply optimization techniques to real life problems.
CO3	Learn and apply neural network prediction algorithm to solve engineering problems.

CO4	Understand and apply fuzzy based logic function for predicting results.
CO5	Acquire and use knowledge of genetic algorithm to optimize real life problems.
CO6	Study different hybrid soft computing methods and its applications.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2							1		2
CO2	2	2	2	2						1		2
CO3	2	2	2	2						1		
CO4	2	2	2	2						1		
CO5	2	2	2	2						1		
CO6	2	2	2	2						1		1

Unit 1

- **INTRODUCTION**
  Soft Computing: Introduction of soft computing, Evolutionary Algorithms vs. Convectional optimization techniques, various types of soft computing techniques, applications of soft computing.
  Artificial Intelligence: Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies. Knowledge representation issues, Prepositional and predicate logic, monotonic and non-monotonic reasoning, forward Reasoning, backward reasoning.

Unit 2

- **OPTIMIZATION CONCEPTS**
  Objective functions, constraints, Search space, local optima, global optima, fitness functions, search techniques, etc.

Unit 3

- **NEURAL NETWORKS**
  Artificial neural network: Introduction, characteristics- learning methods – taxonomy – Evolution of neural networks- basic models – important technologies – applications.
  McCulloch-Pitts neuron – linear separability – hebb network – supervised learning network: perceptron networks – adaptive linear neuron, multiple adaptive linear neuron, BPN, RBF, TDNN- associative memory network: auto-associative memory network, hetero-associative memory network, BAM, hopfield networks, iterative autoassociative memory network & iterative associative memory network – unsupervised learning networks: Kohonenself organizing feature maps, LVQ – CP networks, ART network.

Unit 4

- **FUZZY LOGIC**
  Fuzzy logic: Introduction – crisp sets- fuzzy sets – crisp relations and fuzzy relations: cartesian product of relation – classical relation, fuzzy relations, tolerance and

equivalence relations, non-iterative fuzzy sets.

Membership functions: features, fuzzification, methods of membership value assignments- Defuzzification: lambda cuts – methods – fuzzy arithmetic and fuzzy measures: fuzzy arithmetic – extension principle – fuzzy measures – measures of fuzziness -fuzzy integrals – fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules-decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making.

Unit 5

- **GENETIC ALGORITHM**

  Genetic algorithm- Introduction – biological background – traditional optimization and search techniques – Genetic basic concepts.

  Genetic algorithm and search space – general genetic algorithm – operators – Generational cycle – stopping condition – constraints – classification genetic programming – multilevel optimization – real life problem- advances in GA.

Unit 6

- **HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS**

  Neuro-fuzzy hybrid systems – genetic neuro hybrid systems – genetic fuzzy hybrid and fuzzy genetic hybrid systems – simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.

TEXTS/REFERENCES:

1. J.S.R.Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI /Pearson Education 2004.
2. S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.
3. S.Rajasekaran and G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.
4. George J. Klir, Ute St. Clair, Bo Yuan, "Fuzzy Set Theory: Foundations and Applications" Prentice Hall, 1997.
5. David E. Goldberg, "Genetic Algorithm in Search Optimization and Machine Learning" Pearson Education India, 2013.
6. James A. Freeman, David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India, 1991.
7. Simon Haykin, "Neural Networks Comprehensive Foundation" Second Edition, Pearson Education, 2005.

Semester-I
Communication Skills

BH1101	Communication Skills	Elective	2-0-0	2 Credits

Continuous Assessment 25 Marks	PR/OR 20 Marks	Total 50 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	Students are found to be confident while using English
CO2	Engage in analysis of speeches or discourses and several articles
CO3	Identify and control anxiety while delivering speech
CO4	Write appropriate communications(Academic/Business)
CO5	Prepared to take the examinations like GRE/TOFEL/IELTS
CO6	Identify and control the tone while speaking
CO7	Develop the ability to plan and deliver the well-argued presentations

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1		2		2	1			2	3
CO2	2						1	2		1	2	3
CO3					1		1	2			2	3
CO4	2		1		1		3	1	2	1	2	3
CO5	1											1
CO6					2		2	2			2	3
CO7			2	1	2	2	3	3	1	1	3	3

Course Contents:

Unit 1:

- **Communication and Communication Processes**
  Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication, Ways of Effective Communication.

Unit 2:

- **Oral Communication**
  Use of Language in Spoken Communication, Features of Good Communication, Principles and Practice of Group Discussion, Public Speaking (Addressing Small Groups and Making Presentation), Interview Techniques, Appropriate Use of Non-verbal Communication, Presentation Skills, Telephonic Etiquettes, Extempore, Elocution, Describing Experiences and Events.

Unit 3:

- **Study of Sounds in English**
  Introduction to phonetics, Study of Speech Organs, Study of Phonemic Script,

Articulation of Different Sounds in English, Stress Mark.

Unit 4:

- **English Grammar**
  Grammar: Forms of Tenses, Articles, Prepositions, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Common Errors, Sentence Formation and Sentence Structures, Use of Appropriate Diction.

Unit 5:

- **Writing Skills**
  Features of Good Language, Difference between Technical Style and Literary Style, Writing Emails, Formal and Informal English, Business Writing, Advertisements, Essay Writing, (Technical, Social, and Cultural Topics), Technical Reports: Report Writing: Format, Structure and Types, Writing Memorandum, Circulars, Notices, Agenda and Minutes, Technical Manuals, Brochures
  Letter Writing: Types, Parts, Layouts, Letters and Applications, Use of Different Expressions and Style, Writing Job Application Letter and Resume.

Unit 6:

- **Reading Skills & Listening Skills**
  Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.
  Listening : Importance of Listening, Types of Listening, Barriers to Listening.

TEXTS/ REFERENCE:

1. Mohd. Ashraf Rizvi, *Communications Skills for Engineers*, Tata McGraw Hill
2. Sanjay Kumar, Pushp Lata, *Communication Skills*, Oxford University Press, 2016
3. Meenakshi Raman, Sangeeta Sharma, *Communication Skills*, Oxford University Press, 2017
4. Teri Kwal Gamble, Michael Gamble, *Communication Works*, Tata McGraw Hill Education, 2010

Semester-I
Manufacturing Engineering Laboratory

PE105	**Manufacturing Engineering Laboratory**	**PCC**	**0-0-2**	**1 Credits**

	Continuous Assessment 20 Marks		Total 50 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	Measure cutting forces in turning, milling and drilling operations
CO2	Modelling of machine components using software like ANSYS, LSDYNA
CO3	Experiment on EDM, PCM, Wire EDM

CO4	Design a Pneumatic circuit for a given application
CO5	Optimize the machining processes
CO6	Experiment on CMM, Robotics and PROCAST

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	3	3							2
CO2	3	3	2	3	3							3
CO3	2	2	3	3	3							3
CO4	1	1	3	3								2
CO5	2	1	3									3
CO6	2	2	3	3	3							3

Course Contents:

- Cutting force determination using force dynamometer in CNC Milling operation
- Cutting force determination using force dynamometer in CNC Turning operation
- Experimental study in micromachining using photo chemical machining
- Solid modeling of structural components using modeling software
- Solid modeling of machine components using modeling software
- Analysis of machine components using ANSYS, LSDyna etc. software
- Use of statistical quality control software for process optimization
- Study of EDM/Wire EDM for metal machining.
- Metal casting simulation using PROCAST.
- Sequencing of cylinders using pneumatic trainer kit.
- Modeling of component and determination of mass properties.
- Inspection of an engineering component using CMM.
- Simulation of robot.

Semester-II
Metal Forming Processes

MMF201	Metal Forming Processes	PCC	3-1-0	4 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand theory of plasticity and yield criteria
CO2	Do the mathematical modeling of metal forming processes
CO3	Analyze metal forming processes
CO4	Design rolls for rolling, forging and extrusion
CO5	Describe the latest trends in metal forming

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									1
CO2	3	2	1									1
CO3	3	2	2	3								1
CO4	1	3	3									1
CO5	3	1	1									1

Course Contents:

Unit 1
- Introduction to basic concepts, theory of plasticity, yield criteria (isotropic).

Unit 2
- Hot, cold, and warm working, bulk forming like rolling.

Unit 3
- Forging, extrusion and wire drawing, analytical techniques like upper bound equilibrium (slab).

Unit 4
- Slip line field analysis, forming tools, tools and dies for forging.

Unit 5
- Design of rolls for forging, design of rolls for rolling, extrusion dies.

Unit 6
- Latest trends: forming from mashy stage, isothermal forging, near-net-shape manufacturing.

TEXTS / REFERENCES:

1. K.Lange, *Handbook of Metal Forming*, McGraw Hill, 1985.
2. A. M.Sabaroff , *Forging material and Practices*, Reinhold Publishers, 1982.
3. C.Pearson , *Extrusion of Metals*, Wiley, NewYork, 1980.
4. G.W.Rowe, *Manufacturing Technology*, Vol. I & Vol. II, Ellis Horwood, Chichester, John Willy, New York, 1987.

Semester-II
Casting and Moulding Technology

MMF202	**Casting and Moulding Technology**	**PCC**	**3-1-0**	**4 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Identify suitable casting processes and their working principles to manufacture products.
CO2	Design and analyze the melt flow in mould gating and rise ring system.
CO3	Understanding casting solidification phenomenon and identify various casting defects and their remedies.
CO4	Classify different mould types for plastics product and understood polymerization and synthesis techniques
CO5	Understand different plastics processing methods and their working principles.
CO6	Determine the plastic flow in mould, gating layout and cooling using analysis software.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2									1		1
CO2	2	2	1	2			1		1			
CO3	2		1	2			1					1
CO4	2											1
CO5	2			2					1			1
CO6	2	2	1	1			1		1	1		

Course Contents:

Unit 1
- Metal casting processes part and tool materials, foundry layout and equipment, patterns and cores.

Unit 2
- Melt flow: Flow in gating channels and mold cavity, fluidity, gating systems, flow analysis.

Unit 3
- Solidification: Heat transfer, shrinkage, feeding, growth structures, simulation, casting defects type: attributes, causes and remedies, inspection techniques, expert system.

Unit 4
- Plastics for molding types, chemical composition and structures, polymerization, synthesis techniques.

Unit 5

- Processing methods: calendaring, injection, compression, blow, extrusion and transfer molding, casting and reaction injection molding.

Unit 6

- Plastic flow in mold pressure and shear stress distribution, gating layout, cooling analysis, CAD/CAM for casting and molding: review of existing packages.

TEXTS / REFERENCES:

1. R.W.Heine, C. R.Loper and P.C.Rosenthal, *Principles of Metal Casting*, McGraw Hill, Newyork, 1976.
2. P. C.Mukherjee, *Fundamentals of Metal Casting Technology*, Oxford and IBH Publ. Co. 1979.
3. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
4. A. C. Street , *The Die Casting Book*, Portcullis Press Ltd., SurreyEngland, 1986.

Semester-II
Ultra-Precision Machining

MMF203A	Ultra-Precision Machining	Elective	3-0-0	3 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Define ultra-precision machining, Nano-mechanical, Nano-chemical, Nano-physical and electro-chemical machining.
CO2	Understand mechanism of Nano machining in atomic bit and cluster, Nano indentation and scratching.
CO3	Study and understand mechanism of directional photon, electron, plasma, molecular beam processing.
CO4	Explain mechanism of diamond turning and ultra-precision polishing and grinding
CO5	Understand Nano physical and electrochemical processes.
CO6	Study mechanical and optical measuring system for Nano machining.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1						1			1
CO2	2	1	1						1			1
CO3	2		1						1			1
CO4	2		1						1			1

CO5	2		1						1			
CO6	2		1	2					1			1

Course Contents:

Unit 1:

- **Introduction:** Definition of ultra-precision machining; Taniguchi curves of evolution of accuracy in the twentieth century; definition of Nanotechnology; Positional accuracy of today's manufacturing processes and equipment; Deviational and scattering errors in achieving nanometric resolution. Atomic-bit and atomic cluster processing methods: Nano-mechanical, nano-physical and nano-chemical and –electrochemical processes, their capabilities and advantages.

Unit 2:

- **Mechanism of nano-mechanical processing of atomic clusters**: Processing stress, breaking stress and processing energy density; Concept of size effect in mechanical processing; thresholds of specific energy; Nano-machining, abrasive and adhesive processing, theories of nanometric processing of ductile and brittle materials, and polymers; Failure and fracture under uniform and localized loading; Atomic-bit processing and lattice defect density, theories of nano-indentation and scratching.

Unit 3:

- **Mechanism of nano-physical and -chemical processing of atomic-bits**: Scanning tunneling effect, directional photon, electron and ion beam processing, plasma surface processing, molecular beam processing; Principles of chemical and electro-chemical processing, equilibrium of chemical and electro-chemical reactions.

Unit 4:

- **Nano-processing systems (Nano-mechanical processing) - Diamond turning**: Soft metal single-point diamond turning technology, the ultra-precision CNC machine, plane and spherical mirrors machining; Nano-grinding: technology and requirements, concept of critical depth of cut, size-effect in form and fine grinding, Elid grinding, Elastic emission grinding; mechano-chemical polishing of Si wafers, principles and models; Ultra-precision polishing: Principles of ultra-precision polishing of block gauges, balls and aspherical lenses.

Unit 5:

- **Nano-processing systems (Nano-physical and –electrochemical processing):** Photo beam processing: Thermal and chemical processes in photon beam ablation; Electron and ion beam processing: removal mechanism in electron and ion beam processing, abilities and limitations; scanning tunneling microscope (STM) processing; Chemically reactive milling and etching processes, Chemically reactive deposition and consolidation, electrochemical machining and deposition processes.

Unit 6:

- **Nano-measuring systems:** In-situ processes, mechanical and optical measuring systems, Scanning probe and image processing systems.

TEXTS/REFERENCES:

1. N. Taniguchi, Nanotechnology: Integrated Processing Systems for Ultra-precision and Ultra-fine Products, Oxford University Press Inc., NY, 1996.
2. J. McGeough, Micromachining of Engineering Materials, Marcel Dekker, Inc., NY, 2002.
3. M. C. Shaw, Principles of Abrasive Processing, Oxford: Clarendon Press, 1996.

Semester-II
Lean Manufacturing

MMF203B	Lean Manufacturing	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Machine design and Manufacturing processes-II
Course Outcomes: At the end of the course the student will be able to:

CO1	Define lean manufacturing and Lean thinking concepts.
CO2	Understand philosophy and culture of Toyota production system.
CO3	Learn value stream mapping in Lean manufacturing.
CO4	Study various tools and techniques in lean manufacturing.
CO5	Discuss the importance of problems in change process and training.
CO6	Write the various applications of lean manufacturing process and follow-ups.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				1			1				1
CO2	2				1			1				
CO3	2			1	1			1				
CO4	2			1	1			1				
CO5	2				1		1	1				
CO6	2				1			1				

Course Contents:

Unit 1.
- What is lean production? – Introduction, background, and lean thinking.

Unit 2.
- Importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System.

Unit 3.

- Lean production preparation – System assessment, process and value-stream mapping – Sources of waste.

Unit 4.

- Lean production processes, approaches and techniques.—Importance of focusing upon flow. Tools include: Workplace organization – 5S, Stability, Just-In-Time – One piece flow – Pull, Cellular systems, Quick change and set-up reduction methods, Total productive maintenance, Poka-Yoke – mistake proofing, quality improvement, Standards, Leveling, Visual management.

Unit 5.

- Employee involvement – Teams – Training – Supporting and encouraging involvement – Involving people in the change process -- communication -- Importance of culture.

Unit 6.

- Startup of lean processes and examples of applications. Sustaining improvement and change, auditing, follow-up actions.

TEXTS/REFEENCES:

1. The Toyota Way Fieldbook, Jeffrey Liker and David Meier, McGraw-Hill, 2006.
2. Lean Production Simplified, Pascal Dennis, Productivity Press, 2007.

Semester-II

Sensors for Intelligent Manufacturing and Monitoring

MMF203C	**Sensors for Intelligent Manufacturing and Monitoring**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Machine design and Manufacturing processes-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the importance and need of sensors
CO2	Classify sensors based on different criterion
CO3	Know about the different sensor and its applications.
CO4	Apply knowledge of sensors in manufacturing process and condition monitoring

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	2											1

CO3	2											1
CO4	2		1	1						1		1

Course Contents:

Unit 1
- Introduction-role of sensors in manufacturing automation.

Unit 2
- Principles of different sensors, electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors.

Unit 3
- Condition monitoring of manufacturing systems: principles, sensors for monitoring force, vibration and noise.

Unit 4
- Selection of sensors and monitoring techniques, acoustic emission: principles and applications, concepts of pattern recognition.

Unit 5
- Sensors for CNC machine tools: linear and angular position and velocity sensors, Automatic identification techniques for shop floor control.

Unit 6
- Bar code scanners, radio frequency systems, optical character and machine vision sensors, smart/intelligent sensors, integrated sensors, adaptive control of machine tools.

TEXTS / REFERENCES:

1. D.M.Considiene, G.D.Considine, *Standard Handbook of Industrial Automation*, Chapman and Hall, 1975.
2. *Tool and Manufacturing Engineers Handbook*, Tata McGraw-Hill, SME, Vol. I, II, III, IV, 1985.
3. S. D.Murphy , *In-process Measurement and Control*, Marcel Dekker, 1983.
4. S.Soloman, *Sensors and Control systems in Manufacturing*, McGraw Hill International Editions, USA, 1987.
5. N.Zuech , *Applying Machine Vision*, Wiley International, 1991.

Semester-II
Knowledge Based Systems in Manufacturing

MMF203D	Knowledge Based Systems in Manufacturing	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Define various knowledge bases and data bases for manufacturing.
CO2	Study knowledge representing paradigms.
CO3	Understand fuzzy logic and neutral based systems in manufacturing.
CO4	Study methods of knowledge acquisition and model in manufacturing.
CO5	Design manufacturing application using expert coding languages.
CO6	Analyze defect in processes planning and scheduling in manufacturing.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	2											1
CO3	2			1								
CO4	2											
CO5	2			1								
CO6	2			1							1	

Course Contents:

Unit 1
- Introduction, development of databases and knowledge bases.

Unit 2
- Knowledge representing paradigms-rule based, logic based, object oriented, semantic nets and frames.

Unit 3
- Uncertainty, fuzzy logic, neural nets, inference mechanisms: goals, control strategies, forward and backward chaining.

Unit 4
- Conflict resolution, explanation, blackboard model, implementation issues: knowledge acquisition.

Unit 5
- Coding, expert system shells, PROLOG and LISP, Selected applications in manufacturing, product design.

Unit 6

- Process planning and scheduling, robot movement, factory layout, defect analysis, diagnostic maintenance, quality control, etc.

TEXTS / REFERENCES:

1. R.Kerr, *Knowledge Based Manufacturing Management*, Addison-Wesley, 1991.
2. T. R.Addis, *Designing Knowledge Based Systems*, Prentice Hall, 1985.
3. D.W.Rolston, *Principles of Artificial Intelligence and Expert Systems Development*, McGraw Hill, 1988.
4. R.Maus&J.Keyes, *Handbook of Expert Systems in Manufacturing*, McGraw Hill, 1991.

Semester-II
World Class Manufacturing

MMF203E	**World Class Manufacturing**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Define challenges in world class manufacturing
CO2	Study various world class manufacturing strategies.
CO3	Understand total quality and employee involvement in manufacturing.
CO4	Discuss different world class information system for change management.
CO5	Identify various methods and processes for WCM using brain storming.
CO6	Describe method to monitor performance in WCM.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	2				1							1
CO3	2				1							1
CO4	2			1	1		1					
CO5	2				1		1			1	1	
CO6	2			1			1			1	1	

Course Contents:

Unit 1.

- Historical perspective: World class Excellent organizations – Models for manufacturing excellence – Business Excellence.

Unit 2.

- Benchmark, Bottlenecks and Best Practices: Concepts of benchmarking, bottleneck and best practices, Best performers – Gaining competitive edge throughworld class manufacturing – Value added manufacturing – eliminating waste – Toyota Production System – example.

Unit 3.

- System & tools for world class manufacturing: Improving Product & Process Design – Lean Production – SQC , FMS, Rapid Prototyping , Poka Yoke , 5-S ,3 M, use of IT ,JIT, Product Mix , Optimizing , Procurement & stores practices , Total Productive maintenance , Visual Control.

Unit 4.

- Human Resource Management in WCM: Adding value to the organization – Organizational learning – techniques of removing Root cause of problems – People as problem solvers – New organizational structures . Associates – Facilitators –Teamsmanship – Motivation and reward in the age of continuous improvement.

Unit 5.

- Typical characteristics of WCM companies: Performance indicators – what is world class Performance – Six Sigma philosophy

Unit 6.

- Indian Scenario: Leading Indian companies towards world class manufacturing – Task Ahead.

TEXTS / REFERENCES:

1. World Class Manufacturing - Strategic Perspective - B.S. Sahay ,KBC Saxena , Ashish Kumar(Mac Millan)
2. Making Common Sense Common Practice – Models for manufacturing excellence-Ron Moore (Butter worth Heinmann)
3. The Toyota Way - Jeffrey K.Liker – (Tata Macgraw Hill)
4. Operations Management for Competitive Advantage – Chase
5. Making Common Sense Common Practice – Moore
6. Managing Technology & Innovation for Competitive Advantage – Narayanan
7. Just In Time Manufacturing – M.G.Korgaonkar
8. Machine That Changed The World – Womack

Semester-II
Robotics

MMF203F	**Robotics**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Study the manipulators and its kinematics.
CO2	Classify the actuators and study their characteristics.
CO3	Understand the motions of robots and its control.
CO4	Determination of the solution to inverse kinematics and trajectory planning in robot movements.
CO5	Acquire the knowledge of sensors used in robots.
CO6	Write a program for robot motion and control.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2			1								
CO2	2			1								1
CO3	2			1								
CO4	2			1						2		
CO5	2			1								1
CO6	2			1								

Course Contents:

Unit 1

- Introduction, construction of manipulators, advantages and disadvantages of various kinematic structures.

Unit 2

- Applications, actuators, pneumatic, hydraulic and electric, characteristics and control, non servo robots.

Unit 3

- Motion planning; feed back systems, encoders, servo control PTP and CP, Kinematics.

Unit 4

- Homogeneous so ordinates, solution of the inverse kinematic problem, multiple solutions, Jacobian, work envelopes, trajectory planning.

Unit 5

- Manipulator dynamics and force control, sensors: vision, ranging, laser, acoustic, tactile, developments in sensor technology.

Unit 6

- Sensory control, programming language: VAL, RAIL, AML. Mobile robots, walking robots, walking devices, robot reasoning.

TEXTS / REFERENCES:

1. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, *Robotics*, McGraw Hill New york, 1987.
2. Y. Koren, *Robotics for Engineers*, McGraw Hill, 1985.
3. J. J. Craig, *Robotics*, Addison-Wesley, 1986.

Semester-II
Manufacturing Automation

MMF203G	Manufacturing Automation	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concept of automation and human factors
CO2	Designing a Pneumatic and Hydraulic system for a given application
CO3	Demonstrate the use of different sensors for automation
CO4	Design automation systems for a given application
CO5	Understand the circuit optimization techniques

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2		1						2
CO2	1	1	3	3		2						1
CO3	2	2	2									1
CO4	2	2	3	3								1
CO5	3	3	2	1		1						1

Course Contents:

Unit 1

- Product cycle, manufacturing functions, types of automation, degree of automation, technical, economic and human factors in automation.

Unit 2

- Technologies- mechanical, electrical, hydraulic, pneumatic, electronic, hybrid systems, comparative evaluation.

Unit 3

- Development of small automation systems using mechanical devices, synthesis of hydraulic circuits.

Unit 4

- Circuit optimization techniques, illustrative examples of the above types of systems.

Unit 5

- Industrial logic control systems logic diagramming, programmable controllers.

Unit 6

- Applications, designing for automation, cost-benefit analysis.

TEXTS / REFERENCES:

1. A.N.Gavrilov, *Automation and Mechanization of Production Processes in Instrument Industry*, Pergaman Press, Oxford, 1967.
2. G.Pippengerm, *Industrial Hydraulics*, MGH, New York, 1979.
3. F.Kay , *Pneumatics for Industry*, The Machining Publishing Co., London,1969.
4. A. Ray, *Robots and Manufacturing Assembly*, Marcel Dekker, New York, 1982.

Semester-II
Total Productive Maintenance

MMF203H	Total Productive Maintenance	Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	To increase the productivity of plant and equipment with a modest investment in maintenance.
CO2	Enhance knowledge of key operational activities of the quality management system
CO3	To know the causes for accelerated deterioration while production.
CO4	To identify then prioritize and eliminate the causes of the losses.
CO5	Employing consultants to create this culture is common practice.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3		3	3	1	1	3			2

CO2	3			1	3	2	3					2
CO3	3	3	1	1	3		1	1	1			
CO4	1	1		3	3	2	1		3		1	3
CO5	3	2			3	3	2				1	3

Course Contents:

Unit 1

- Outline of TPM. Maintenance Concepts, Objectives and functions, Tero technology, Reliability Centered, Maintenance, (RCM), maintainability prediction, availability and system, effectiveness, organization for maintenance.

Unit 2

- TPM-challenging limits, maximizing equipment effectiveness, Maintenance Models, Minimal repair, maintenance types, balancing preventive maintenance, and breakdown maintenance, preventive maintenance schedules: deviations on target values, preventive maintenance schedules: functional characteristics, replacement models.

Unit 3

- Organizing for TPM implementation, PM Concepts, Importance of TPM, Zero breakdown concepts, Zero Defects and TPM, maximizing equipment effectiveness, autonomous maintenance program, five pillars of TPM, TPM Small group activities.

Unit 4

- TPM implementation and stabilization, TPM Planning and Implementation, Organization for TPM, management decision, awareness and training for TPM, establishment of basic policies and goals, formation of master plan, TPM implementation, Ongoing global trends in TPM.

Unit 5

- TPM small group activities, Maintenance Logistics, Human factors in maintenance, maintenance manuals, maintenance staffing methods, queuing applications, simulation, spare parts management, maintenance planning and scheduling.

Unit 6

- The PM prize for outstanding TPM plants, Online Monitoring Condition Monitoring Techniques, Vibration Monitoring and Signature Analysis. Wear Debris Monitoring, Maintenance Management Information System, Expert systems, Corrosion Monitoring and Control.

TEXTS / REFERENCES:

1. Nahchi-Fujikoshi Corporation, *Training For TPM*, Japan Institute of Plant Maintenance, 1990.
2. S.Nakajjima, *Introduction To TPM, The Purtor Factory*, Japan Institute of Plant Maintenance, 1986.
3. S. Nakajima, *TPM Nyumon*, The Japan Institute of Plant Maintenance, 1989.

4. S.Nakajima, *TPM Maintenance Prevention Design Productivity,* Press Inc. First Indian Edition, 1993.
5. K.Shirose, Y.Kimura, and M.Kaneda, *An Advanced Step In TPM Implementation*, Japan Institute Of Plant Maintenance, 1990, 1995.

Semester-II
Metrology and Computer Aided Inspection

MMF203I	**Metrology and Computer Aided Inspection**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Explain high precision measurement requirements of industry and select instruments for high precision.
CO2	Using various measuring standards and instruments for different applications.
CO3	Calibrate basic metrology instruments used in machine shop, and Identify techniques to minimize the errors in measurement.
CO4	Employing limits and design gauges
CO5	Explain the different instruments used for linear and angular measurements, surface finish and form features of a component
CO6	Identify the advanced measurement principles with ease and operate sophisticated measurement machines.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1			2	2						1
CO2	2	1	3	1	1	1						
CO3	2	2		3								2
CO4	2	2	2		3							2
CO5		1	1		1							1
CO6						3						2

Course Contents:

Unit 1

- Metrological concepts, Abbe's principle, need for high precision measurements, problems associated with high precision measurements.

Unit 2

- Standards for length measurement, shop floor standards and their calibration, light interference, method of coincidence.

Unit 3

- Slip gauge calibration, measurement errors, various tolerances, and their specifications, gauging principles.

Unit 4

- Selective assembly, comparators, angular measurements, principles and instruments, gear and thread measurements.

Unit 5

- Surface and form metrology, computer aided metrology, principles and interfacing, software metrology, laser metrology, CMM, types, probes used applications.

Unit 6

- Non-contact CMM using electro-optical sensors for dimensional metrology, non-contact sensors for surface finish measurements, image processing and its applications in metrology.

TEXTS / REFERENCES:

1. D.J.Whitehouse, *Handbook of Surface Metrology*, Inst. of Physics Bristol and Philadelphia, 1994.
2. R.K.Jain, *Engineering Metrology*, Khanna Publishers, 2000.
3. Galleyer and Shotbolt, *Metrology for Engineers*, ELBS, 1998.

Semester-II
Mechatronics

MMF203J	**Mechatronics**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Basic Electronics

Course Outcomes: At the end of the course, the student will be able to:

CO1	Define sensor, transducer and understand the applications of different sensors and transducers
CO2	Explain the signal conditioning and data representation techniques
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Write a PLC program using Ladder logic for a given application

CO5	Understand applications of microprocessor and micro controller
CO6	Analyze PI, PD and PID controllers for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1
CO2	3	2			3	3	2				1	3
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3			1	3	2	3					2
CO6		3	3		3	3	1	1	3			2

Course Contents:

Unit 1

- Introduction to Mechatronic systems, elements, advantages and practical examples of Mechatronic systems.
- **Sensors and Transducers:**
  Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tuctile sensors, Selection of sensors.

Unit 2

- **Signal Conditioning and Data Representation**Types of electronic signals, Need for signal processing, Operational amplifiers: Types, classification and applications, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Interfacing devices, Electro-magnetic Relays, Data representation systems, Displays, Seven segment displays, LCD displays, Printers, Data loggers, Data Acquisition Cards/Systems

Unit 3

- **Drives:**
- **Electrical Drives:** Types of Electrical Motors, AC and DC motors, DC servomotors, Stepper motors, linear motors, etc.
- **Pneumatics and Hydraulics**
  Components of Pneumatic systems, actuators, direction control valves, pneumatic air preparation, FRL unit, methods of actuation of valves, Sequencing of Pneumatic cylinders using Cascade and shift register methods. Electro-pneumatic valves, Electro- pneumatic circuits using single and double solenoid methods.
  Hydraulic cylinders, design of cylinder, Design of Piston and piston rod, Valves, poppet valve, house pipes and design of tubing, Meter-in and Meter-out circuits.

Unit4

- **Microprocessor and Microcontroller**
- 8085 microprocessor, architecture, various types of registers and their functions in 8085µP, Instruction sets, interfacing, applications. 8081 microcontroller, architecture, Instruction

sets, various pins and their functions interfacing, applications.

- **Programmable Logic Controller**
  Introduction, Architecture, Types of inputs/outputs, Specifications, guidelines for Selection of PLCs, Programming: Ladder logic and FBD

Unit 5

- **Control Systems**
  Open and closed loop system; block diagram manipulation/reduction, Transfer function, modeling of Mechanical Systems using spring, Dashpot and Masse quivalence.

Unit 6

- **Stability of Systems**
  On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers, Introduction to control using state variable system models, Bode Plots and stability criteria.

TEXTS / REFERENCES:

1. HMTLimited, *Mechatronics, TataMcGraw*-Hill, 1998.
2. Bolton,W.,*Mechatronics;ElectronicControlSysteminMechanicalEngineering*, PearsonEducationAsia,1999.
3. Raven, *AutomaticControlEngineering, McGrawHill,NewYork,1986*

Semester-II
Processing and Characterization Techniques

MMF203K	Processing and Characterization Techniques	Elective	3-0-0	3 Credits

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: Materials Engineering

Course Outcomes: At the end of the course, the student will be able to:

CO1	Enhance knowledge on processing for different material.
CO2	To know the characteristic and properties after processing of material.
CO3	To know about latest characterization technique.
CO4	Enhance knowledge of thermal analysis technique
CO5	To examine fine detail using microscope

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	3		3	3	1	1	3			2
CO2	3			1	3	2	3					2
CO3	3	3	1	1	3		1	1	1			
CO4	1	1		3	3	2	1		3		1	3
CO5	3	2			3	3	2				1	3

Course Contents:

Unit 1

- Processing: melting and casting, heat treatment, thermo-mechanical processing, sheet metal forming and welding.

Unit 2

- Structural characterization: phase transformation, electron microscopy, crystallography by using modern techniques. Properties: mechanical properties (like fatigue, fracture toughness, integrity assessment) relating to structure and processing, corrosion evaluation.

Unit 3

- Characterization Techniques: X-ray diffraction, crystal structure and phase identification, residual stress measurement and other applications.

Unit 4

- Outline of thermal analysis technique, description of DTA/DSC/TGA techniques and instrumentation, applications and case studies.

Unit 5

- Optical microscopy – light optics, microscope components, possibilities and limitations. Scanning Electron Microscopy – Optics and performance of a SEM, image interpretation, crystallographic information in a SEM, analytical microscopy.

Unit 6

- Transmission Electron Microscopy – Construction and operation of a TEM, Electron diffraction, image interpretation. IR- and Raman spectroscopy.

TEXTS / REFERENCES:

1. K.Tien and J.F.Elliott (eds), Metallurgical Treatises, Metall. Soc. AIME, 1981
2. G.E. Dieter, Mechanical Metallurgy, McGraw-Hill Book Co. (Third edition), 1988.
3. K. W. Andrews, Physical Metallurgy Techniques and Applications, Vol. 1 and 2, George Allen & Unwin, London, 1973
4. E. N. Kaufmann (Ed. in chief), Characterization of Materials, Vol 1. and 2, John Wiley and Sons Publication, New Jersey, 2003
5. Metals handbook, Vol. 9, Characterization of Materials, 10th Ed., American Society of Metals, Metals Park, OH, USA, 1986.
6. H.H. Willard, L.L. Merrit, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, 6th Ed., CBS Publishers & Distributors, Delhi, 1986.

Semester-II
Micro - Nano Engineering

MMF203L	**Micro - Nano Engineering**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	To expose the students to the evolution of Nano systems, to the various fabrication techniques.
CO2	To impart knowledge to the students about nano materials and various nano measurements techniques.
CO3	To develop the student's skills and knowledge in micro and nano-engineering.
CO4	To investigate molecular surface structures and their electronic properties.
CO5	To discuss the different modeling concepts of micro and nanostructures.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	2				2	1		1
CO2	3			1	3	2	3					2
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3	2			3	3	2				1	3

Course contents:

Unit 1

- **Introduction to micro and nano**
  Basic concepts of micro and Nanotechnology – Quantum wire – Quantum well – Quantum dot – fullerenes
- **Fabrication of micro and nanostructures**
  Nanofabrication
- **Characterization of micro and nanostructures**
  Field Emission Scanning Electron Microscopy (FESEM) – Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM) –Scanning
- **Zero and three dimensional micro and nanostructures**
  Nanoparticles through homogeneous nucleation growth- kinetically confined synthesis of nanoparticles-Classification of Nanoparticle Synthesis Techniques - Solid-State Synthesis of Nanoparticles
- **Fabrication of arrays of Si micro / nano structures based on atom lithography**
  Introduction to Atom Lithography based on Metastable atoms beam (MAB) and Self Assembled
- **Micro and nanostructure modeling**
  Studies on microstructure systems using atomistic and mesoscale simulations – Solid liquid phase-Graphene – Carbon nanotubes – Material processing by chemical vapor

deposition and physical vapor deposition- applications of nanomaterials.

Unit 2

- Photolithography and its limitation-Electron-beam lithography (EBL)- Nanoimprint – Softlithography patterning.

Unit 3

- Tunneling Microscope (STM)-Surface enhanced Raman spectroscopy (SERS)- X-ray Photoelectron Spectroscopy (XPS)

Unit 4

- Mechanical alloying and mechanical milling - Vapor-Phase Synthesis of Nanoparticles - Inert Gas Condensation of Nanoparticles - Plasma-Based - Flame-Based - Spray Pyrolysis based Synthesis of Nanoparticles - Solution Processing of Nanoparticles - Sol-Gel Processing - Solution Precipitation

Unit 5

- Monolayer structures (SAMs) – Principle and procedure - Mechanism of forming SAMs on Si substrates.

Unit 6

- transition under confinement – Modeling of metals - Simulation protocol – Semiemprical methods - Density functional theory mehods (DFT) - Visualization and analysis.

TEXTS / REFERENCES:

1. Sami Franssila, "Introduction to Microfabrication", Wiley Publications, 2010.
2. Cao G., "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", Imperial College Press, 2004.
3. T.Pradeep, "A Text Book of Nanoscience and Nanotechnology", Tata McGraw Hill, New Delhi, 2012.
4. Sam Zhang, "Materials Characterization Techniques", CRC Press, 2008.
5. Rao C. N., A. Muller, A. K. Cheetham, "Nanomaterials Chemistry", Wiley- VCH ,2007.
6. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002.
7. Nabok A., "Organic and Inorganic Nanostructures", Artech House, 2005. 2. Dupas C., Houdy P., Lahmani M., "Nanoscience: Nanotechnologies and Nanophysics", Springer-Verlag Berlin Heidelberg, 2007.

Semester-II
Modeling and Simulation

MMF203M	**Modeling and Simulation**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Define simulation, its limitations and applications.
CO2	Apply simulation to queuing and inventory situations.

CO3	Acquire knowledge to generate the random numbers for simulation models.
CO4	Analyze the data and verify model of simulation.
CO5	Learn software’s and programming languages for developing simulation model.
CO6	Discuss case studies in manufacturing simulation.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	2			1								
CO3	2	2	1	2								1
CO4	2	2	1	2						2	1	
CO5	2	2	2	3						1		2
CO6	2						2			1		

Course Contents:

Unit 1

- Introduction to systems and modeling – discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation.

Unit 2

- Discrete event simulation and their applications in queueing and inventory problems.

Unit 3

- Random number generation and their techniques - tests for random numbers. Random variable generation.

Unit 4

- Analysis of simulation data. - Input modeling – verification and validation of simulation models – output analysis for a single model.

Unit 5

- Simulation languages and packages - FORTRAN, C, C++, GPSS, SIMAN V, MODSIM III, ARENA, QUEST, VMAP - Introduction to GPSS – Case studies.

Unit 6

- Simulation of manufacturing and material handling system, Caste studies.

TEXTS / REFERENCES:

1. Jerry Banks and John S, Carson II “Discrete Event System Simulation”, Prentice Hall,
2. 1984.
3. Geoffrey Gordon., “System Simulation”, Prentice Hall, 1978.
4. Francis Neelamkovil, “Computer Simulation and Modelling”, John Willey and sons, 1987.

Semester-II
Numerical Methods & Computational Techniques

MMF203N	Numerical Methods & Computational Techniques	Elective	3-1-0	4 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, student should be able to:

CO1	Solve a set of algebraic equations representing steady state models formed in engineering problems
CO2	Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables
CO3	Predict the system dynamic behavior through solution of ODEs modeling the system
CO4	Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.
CO5	Demonstrate proficiency of using MATLAB,VB,ANSYS,EES etc.,

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	1									
CO2			1									
CO3	1					1						
CO4		1		2								
CO5		1		1								
CO6		2	1	3								2

Course Contents:

Unit 1
- Introduction to Numerical Analysis: Objectives, Mathematical Modeling, Programming Concepts, MATLAB, Computational Accuracy, Precision, Truncation Errors, Taylor Series
- Curve fitting and Regression, Interpolation, Fourier Series concepts

Unit 2
- Roots of equations: Bisection, False position, Fixed Point Iteration, Newton-Raphson, Secant methods, Roots of polynomials
- Linear Algebraic Equations, Gauss Elimination

Unit 3
- Non-linear Systems of Equations, Gauss-Jordan, LU Decomposition and Matrix Inversion, Gauss-Seidel, Optimization concepts

Unit 4

- Numerical Integration: Trapezoidal and Simpson's Rules, Gaussian Quadrature
- Numerical Differentiation and finite-difference approximations

Unit 5

- Ordinary Differential Equations: Euler's and Runge-Kutta Methods, Boundary-Value, Eigen value and Eigen vector Problems

Unit 6

- Partial Differential Equations: Elliptic Equations, Laplace Equation and Boundary Conditions, Control Volume Approach, Parabolic Equations, Explicit and Implicit Methods, Crank-Nicolson, Introduction to Finite Element Methods

TEXTS / REFERENCES:

1. Steven C. Chapra and Raymond P. Canale, Numerical Method for Engineers, 6th Edition, McGraw-Hill, 2010.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, 5th Edition, PHI Learning, 2012
3. S. P. Venkateshan, Computational Methods in Engineering, 1st Edition, Academic Press, 2013
4. S.K. Gupta, Numerical Methods for Engineers, New Age International, 2009
5. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge, 2007
6. K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Edition, Wiley-India, 2004.
7. J. D. Hoffman and Steven Frankel, Numerical Methods for Engineers and Scientists, 2nd Edition, McGraw-Hill, 2001
8. S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Edition, McGraw-Hill, 1980.

Semester-II
CAD-CAE

MMF203O	**CAD-CAE**	**Elective**	**3-0-0**	**3 Credits**

Class Test	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Course Pre-requisites: Numerical Methods & Computational Techniques (PC3), Structured or Object Oriented Programming (FORTRAN / C / C++ / Java / VB)
Course Outcomes: At the end of the course, student should be able to:

CO1	Demonstrate - Polynomial and spline interpolation, Bezier curves, B-splinesto surfaces representation, patches and composite surfaces.
CO2	Design and create Solid model assembly of thermal and fluid engineering system in CAD software.
CO3	Analyse simple Engineering problem by selecting appropriate Mesh generation.

CO4	Modeling and Meshing of Thermal and Fluid Flow equipment in CAD.
CO5	Simulate and demonstrate Thermal and Fluid systems by using ANSYS, EES, MATLAB etc.
CO6	Understand and simulate computer aided manufacturing.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		1		1	1							
CO3		2		1								
CO4	1	1		1								
CO5	1	1		3								
CO6	1	1										

Course Contents:

Unit 1

- Overview of CAD Applications, Curves - Polynomial and spline interpolation, Bezier curves, B-splines, Introduction to surfaces representation, patches and composite surfaces
- Solid Modeling: Representation of Solids, Topology, Wireframe, Boundary representation (B-Rep), CSG, Solid modeling operations

Unit 2

- Computer Graphics: Mathematical principles for 2D and 3D visualization, Matrix transformations, Modeling, viewing, projection and rendering, OpenGL graphics library
- Meshing – Mesh topology, Data structures, Introduction to Mesh generation algorithms, Surface meshes, Element types and quality criteria

Unit 3

- CAD data formats and exchange
- Hands-on lab sessions: Modeling and Meshing of Thermal and Fluid Flow equipment

Unit 4

- Computer Aided Engineering: Lab simulations for Thermal and Heat Transfer

Unit 5

- Computational Fluid Dynamics: Lab simulations for Fluid Flow

Unit 6

- Computer Aided Manufacturing - CAD/CAM data exchange, CAD/CAM integration,

TEXTS / REFERENCES:

1. Ibrahim Zeid and R Sivasubramanian, CAD/CAM : Theory and Practice, McGraw-Hill, Special Indian Edition, 2009
2. Ibrahim Zeid, Mastering CAD / CAM, McGraw-Hill, 2nd Edition, 2006
3. Gerald Farin, Curves and Surfaces for CAGD: A Practical Guide, Elsevier India, 5th Edition, 2013

4. Micheal E. Mortenson, Geometric Modeling, Industrial Press, 3rd Edition, 2006
5. Peter Shirley, Michael Ashikhmin and Steve Marschner, Fundamentals of Computer Graphics, A K Peters/CRC Press, 3rd Edition, 2009
6. David Rogers and J.A. Adams, Mathematical Elements for Computer Graphics, McGraw-Hill, 2nd Edition, 2002
7. Hartmut Prautzsch and Wolfgang Boehm, Geometric Concepts for Geometric Design, A K Peters/CRC Press, 1993
8. Computational Geometry for Design and Manufacture, Faux I. D. and Pratt M. J., Ellis Horwood, 1980

Semester-II
Machine Learning Techniques

MMF203P	**Machine Learning Techniques**	**Elective**	**3-0-0**	**3 Credits**

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, student should be able to:

CO1	Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
CO2	Perform evaluation of learning algorithms and model selection.
CO3	Apply knowledge representation, reasoning, and machine learning techniques to real-world problems
CO4	Proficiency with a variety of classifier methods including decision trees, neural networks, naïve bayes learning, nearest neighbor methods.
CO5	Illustrate hybrid learning methods involving domain theories and adaptive learning methods, and create algorithm by using this.
CO6	Apply this techniques to control and teach something to robot.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2		2								1
CO2	1	1		2		1						
CO3						2						
CO4	1	2										
CO5	1	1										
CO6	2		1		1							1

Course Contents:

Unit 1

- **FOUNDATIONS OF LEARNING**

  9 Components of learning – learning models – geometric models – probabilistic models – logic models – grouping and grading – learning versus design – types of learning – supervised – unsupervised – reinforcement – theory of learning – feasibility of learning – error and noise – training versus testing – theory of generalization – generalization bound – approximationgeneralization tradeoff – bias and variance – learning curve 37 [

Unit 2

- **LINEAR MODELS 9**
- Linear classification – univariate linear regression – multivariate linear regression – regularized regression – Logistic regression – perceptrons – multilayer neural networks – learning neural networks structures – support vector machines – soft margin SVM – going beyond linearity – generalization and overfitting – regularization – validation

Unit 3

- **DISTANCE-BASED MODELS 9**

  Nearest neighbor models – K-means – clustering around medoids – silhouttes – hierarchical clustering – k-d trees – locality sensitive hashing – non-parametric regression – ensemble learning – bagging and random forests – boosting – meta learning

Unit 4

- **TREE AND RULE MODELS 9**

  Decision trees – learning decision trees – ranking and probability estimation trees – regression trees – clustering trees – learning ordered rule lists – learning unordered rule lists – descriptive rule learning – association rule mining – first-order rule learning

Unit 5

- **REINFORCEMENT LEARNING 9**

  Passive reinforcement learning – direct utility estimation – adaptive dynamic programming – temporal-difference learning – active reinforcement learning – exploration – learning an action utility function – Generalization in reinforcement learning – policy search – applications in game playing – applications in robot control

TEXTS/REFERENCES:

1. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, “Learning from Data”, AMLBook Publishers, 2012.
2. P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
3. K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012.
4. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
5. D. Barber, “Bayesian Reasoning and Machine Learning”, Cambridge University Press, 2012.
6. M. Mohri, A. Rostamizadeh, and A. Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.
7. T. M. Mitchell, “Machine Learning”, McGraw Hill, 1997. 8. S. Russel and P. Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Prentice Hall, 2009.

Semester-II
Research Methodology

MMF204A	Research Methodology	Open Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Understand and Describe importance of research.
CO2	Classify and select appropriate resources for Research.
CO3	Analyze the contents of literature and identify further scope.
CO4	Formulate a Research Problem.
CO5	Develop effective written and oral Presentation skills.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		3				1		3			2
CO2	2		2	1			1		1			2
CO3	2		3	3			1		1	2		2
CO4	2	3	3	2					2	2		2
CO5	2		1	3			3					3

Course contents:

Unit 1
- Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit 2
- Research process – Criteria for good research – Problems encountered by Indian researchers. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit 3
- Hypothetical proposals for future development and testing, selection of Research task.

Unit 4
- Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

Unit 5

- Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

TEXTS/REFERENCES

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Semester-II
Design of Experiments

MMF204B	Design of Experiments	Open Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1	1	1	1	1		1	1	1
CO2	3	2	1	3	2	1	2	1	1	2	1	1
CO3	3	2	1	3	2	1	2	1	1	2	1	1
CO4	3	3	1	3	2	1	2	1	1	2	1	1
CO5	2	3	1	2	3	2	2	1	1	2	1	1

Course Contents:

Unit 1

- Introduction: Modern quality control, quality in engineering design, history of quality engineering.
- The Taguchi Approach to quality: Definition of quality, loss function, off-line and on-line quality control, Taguchi`s quality philosophy.

Unit 2

- Full Factorial Designs: Experimentation as learning process, traditional scientific experiments, three factor design, replicating experiments, factor interactions, normal plots of estimated effects, mechanical plating experiments, two factor design, four factor design, Taguchi design and western design.

Unit 3

- Fractional Factorial Design: Fractional factorial design based on eight run experiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over an sixteen run experimental design, blocking two level designs, other two level designs.

Unit 4

- Evaluating Variability: Necessity to analyze variability, measures of variability, the normal distribution, using two level designs to minimize variability, signal-to-noise ratio, minimizing variability and optimizing averages.
- Taguchi Inner and Arrays: Noise factors, experimental designs for control and noise factors, examples.

Unit 5

- Experimental Design for Factors at Three and Four level: Necessity to use more than two level, factors at four levels, factors at three levels.
- Analysis of Variance in Engineering Design: Hypothesis testing concepts, using estimated effects as test statistics, analysis of variance for two level designs, when to use analysis of variance.

Unit 6

- Computer Software for Experimental Design: Role of computer software in experimental design, summery of statistical packages, example of use of software packages.
- Using Experiments to improve Processes: Engineering design and quality improvement, steps to implementing use of engineering design.

TEXTS / REFERENCES:

1. D.C.Montgomery, *Design and Analysis of Experiments*, 5th Edition, John Wiley and Sons, NewYork, 2004.
2. R.H.Lochner and J.E.Matar, *Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design*, Chapman and Hall, London, 1983.

Semester-II
Advanced Optimization Techniques

MMF204C	Advanced Optimization Techniques	Open Elective	3-0-0	3 Credits

Class Test 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Prerequisite: None
Course Outcomes: At the end of the course the student will be able to:

CO1	Enables to acquire mathematical methods and apply in engineering disciplines.
CO2	Apply methods of optimization to solve a linear, non-linear programming problem by various methods
CO3	Optimize engineering problem of nonlinear-programming with/without constraints, by using this techniques
CO4	Use of dynamic programming problem in controlling in industrial managements.
CO5	Simulate Thermal engineering system problem. Understand integer programming and stochastic programming to evaluate advanced optimization techniques.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1		1		1
CO2	2	1	1					1				
CO3		2							1			
CO4	1				2	1				2		1
CO5			1	2	1	1	2		1	2		1

Course Contents:

Unit 1
SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

Unit 2
MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION: Direct search method –Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method.
Variable metric method.

Unit 3
GEOMETRIC PROGRAMMING: Polynomials – arithmetic – geometric inequality – unconstrained G.P– constrained G.P
DYNAMIC PROGRAMMING: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic

programming, production inventory. Allocation, scheduling replacement.

Unit 4
LINEAR PROGRAMMING: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints.
Simulation: Introduction – Types – Steps – application – inventory – queuing – thermal system.

Unit 5
INTEGER PROGRAMMING: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.
STOCHASTIC PROGRAMMING: Basic concepts of probability theory, random variables Distributions – mean, variance, Correlation, co variance, joint probability distribution stochastic linear, dynamic programming.

TEXTS/REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia
7. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia

Semester-III
Project Management and Intellectual Property Rights

MMF301	Project Management and Intellectual Property Rights	PCC	0-0-4	2 Credits

End-Semester Exam	Total
50 Marks	50 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course the student will be able to:

CO1	• Enumerate and demonstrate fundamental terms such as copy-rights ,Patents ,Trademarks etc.,
CO2	• Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.
CO3	• exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.
CO4	• Develop awareness at all levels (research and innovation) of society to develop patentable technologies.
CO5	• Apply trade mark law, copy right law, patent law and also carry out intellectual property audits

CO6	• Manage and safeguard the intellectual property and protect it against unauthorized use

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1					1		1			
CO2	1		2				1		2			2
CO3						1		1				
CO4						1			1			
CO5			1						1			1
CO6												

Course Contents:

A. Project Management:
Unit-1

- Introduction to Project management**:** Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization. Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks.

Unit-2

- Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.

Unit-3

- Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.

B. IPR:
Unit-4

- Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents ;their definition; granting; infringement ;searching & filing; Utility Models an introduction;

Unit-5

- Copyrights ; their definition; granting; infringement ;searching & filing, distinction between related and copy rights; Trademarks ,role in commerce ,importance , protection, registration; domain names;

Unit-6

- Industrial Designs ; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications , international protection; Plant varieties; breeder's rights, protection; biotechnology& research and rights managements; licensing, commercialization; ; legal issues, enforcement ;Case studies in IPR.

TEXT BOOKS/REFERENCES:

1. Shtub,BardandGloberson,ProjectManagement:Engineering,Technology,andImplementation,Prentice Hall, India
2. Lock, Gower, Project Management Handbook.
3. Prabuddha Ganguli, IPR published by Tata McGraw Hill 2001

Semester -II
Seminar-I

MPE205	Seminar-I	PCC	0-0-4	2 Credits

Continuous Assessment	PR/OR	Total
50 Marks	50 Marks	100 Marks

Course Outcomes: At the end of the course the student will be able to:
Pre-Requisites: Previously studied courses.

CO1	Identify and compare technical and practical issues related to the area of course specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Prepare a well organized report employing elements of technical writing and critical thinking.
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		1	2		2	2	2	1	2
CO2		2				2		1	2	1		1
CO3						1	1	2	2	2		2
CO4	1	2	1	1		1	1	1	2	1		1

Objective:
To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self-confidence and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from Manufacturing Systems Management related topics preferably from outside the M.Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a manufacturing organization. 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.

Semester-II
Mini Project

MPE206	Mini Project	PCC	0-0-4	2 Credits

Continuous Assessment	PR/OR	Total
50 Marks	50 Marks	100 Marks

Pre-Requisites: Previously studied courses.
Course Outcomes: At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2
CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

Objectives:
To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group
activities.

Individual students are required to choose a topic of their interest. The content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organisations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.
Mini Project will have internal marks 50 and Semester-end examination marks 50.

Internal marks will be awarded by respective guides as per the stipulations given below.
Attendance, regularity of student (20 marks)
Individual evaluation through viva voce / test (30 marks)
Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, beforethe committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.
Report = 25 marks
Concept/knowledge in the topic = 15 marks
Presentation = 10 marks
Total marks = 50 marks

Semester-III
Masters Research Project (Phase – I)

MPE302	**Masters Research Project (Phase – I)**	**PCC**	**0-0-0**	**10 Credits**

Continuous Assessment 50 Marks	PR/OR 50 Marks	Total 100 Marks

Pre-Requisites: Previously studied courses.
Course Outcomes: At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2

CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

Objective:
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project, experimental project, computer simulation project or an empirical study involving data collection and analysis from manufacturing organisations. The topic should be on Manufacturing Systems Management orany of the topics related with Manufacturing stream. The project work is allotted individually on different topics.The students shall be encouraged to do their project work in the parent institute. If found essential they may be permitted to continue their project outside the parent institute subject to the conditions of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members. The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4th semester (Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Semester-IV
Masters Research Project (Phase – II)

MPE401	Masters Research Project (Phase – II)	PCC	0-0-0	20 Credits

Continuous Assessment	PR/OR	Total
100 Marks	100 Marks	200 Marks

Pre-Requisites: Previously studied courses.
Course Outcomes: At the end of the course the student will be able to:

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2
CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

Objectives:
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.
Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.