Course Curriculum

MTech

IN

MANUFACTURING TECHNOLOGY

2016

Department of Mechanical Engineering

JAYPEE UNIVERSITY OF ENGINEERING & TECHNOLOGY

A-B ROAD, RAGHOGARH, DT. GUNA-473226 MP, INDIA

TEACHING SCHEME

2 year M. Tech. Course Curricula for Manufacturing Technology							
M. Tech. I semester (M1)							
S. No.	**Subject Code**	**Subject**	**Core / Elective**	**L**	**T**	**P**	**Credits**
1	14M11ME111	Analysis and Design of Machine Tools	Core	3	0	0	03
2	14M11ME112	Metal Machining	Core	3	0	0	03
3	14M11ME113	Casting and Welding	Core	3	0	0	03
4	14M11ME114	Unconventional Manufacturing Processes	Core	3	0	0	03
5	14M17ME172	Metal Machining Lab	Core	0	0	2	01
6	14M17ME173	Casting and Welding Lab	Core	0	0	2	01
7		DE –-I	Elective	3	0	0	03
		Total		**15**		**4**	**17**
List of Electives for DE-I to be updated from time to time			**Core / Elective**	**L**	**T**	**P**	**Credits**
1	14M14ME131	Industrial Inspection and Quality Control	Elective	3	0	0	3
2	14M14ME132	Quality Engineering	Elective	3	0	0	3
3	14M14ME133	Tool and Die Design	Elective	3	0	0	3

2 year M. Tech. Course Curricula for Manufacturing Technology							
M. Tech. II semester (M2)							
S. No.	**Subject Code**	**Subject**	**Core/ Elective**	**L**	**T**	**P**	**Credits**
1	14M11ME211	Computer Integrated Manufacturing	Core	3	0	0	03
2	14M11ME212	Mechanics of Metal Forming	Core	3	0	0	03
3	14M11ME213	Additive Manufacturing Process	Core	3	0	0	03
4	14M11ME214	Mechatronics	Core	3	0	0	03
5	14M17ME271	Computer Integrated ManufacturingLab	Core	0	0	2	01
6	14M17ME272	Metal Forming Lab	Core	0	0	2	01
7		DE – II	Elective	3	0	0	03
		Total		**15**		**4**	**17**
List of Electives for DE-II to be updated from time to time			**Core/ Elective**	**L**	**T**	**P**	**Credits**
1	14M14ME231	Industrial Tribology	Elective	3	0	0	3
2	14M14ME232	Experimental Mechanics and Non-Destructive Testing	Elective	3	0	0	3
3	14M14ME233	Advanced Materials Technology	Elective	3	0	0	3

2 year M. Tech. Course Curricula for Manufacturing Technology							
M. Tech. III semester (M3)							
S. No.	**Subject Code**	**Subject**	**Core/ Elective**	**L**	**T**	**P**	**Credits**
1		DE– III	Elective	3	0	0	03
2		DE – IV	Elective	3	0	0	03
3	14M19ME391	Seminar I	Core	0	0	4	02
4	14M19ME392	Dissertation Part I*	Core	0	0	24	12
	* to be continued in Semester IV						
		Total		**6**	**0**	**28**	**20**
List of Electives for DE-III & DE-IV to be updated from time to time			**Core/ Elective**	**L**	**T**	**P**	**Credits**
DE-III							
1	14M14ME331	Hydraulic and Pneumatic Control System	Elective	3	0	0	3
2	14M14ME332	Micro-Fabrication	Elective	3	0	0	3
3	14M14ME333	Robotics and Automation	Elective	3	0	0	3
4	14M14ME334	Operations and Supply Chain Management	Elective	3	0	0	3
5	15M14ME338	Modelling and Optimization Techniques in Engineering	Elective	3	0	0	3
DE-IV							
1	14M14ME335	Laser Beam Machining	Elective	3	0	0	3
2	14M14ME336	Advanced Composite Materials	Elective	3	0	0	3

3	14M14ME337	Computer Aided Design and Drafting	Elective	3	0	0	3
M. Tech. IV semester (M4)							
S. No.	**Subject Code**	**Subject**	**Core/ Elective**	**L**	**T**	**P**	**Credits**
1		DE – V	Elective	3	0	0	03
2		DE – VI	Elective	3	0	0	03
3	14M19ME491	Seminar II	Core	0	0	4	02
4	14M19ME492	Dissertation Part II*	Core	0	0	28	14
		Total		**6**	**0**	**32**	**22**
List of Electives for DE-V & DE-VI to be updated from time to time			**Core/ Elective**	**L**	**T**	**P**	**Credits**
DE-V							
1	14M14ME431	Finite Element Analysis	Elective	3	0	0	3
2	14M14CL452	Environmental Engineering	Elective	3	0	0	3
3	14M14CI132	Artificial Intelligence in Manufacturing	Elective	3	0	0	3
DE-VI							
1	14M14ME432	Concurrent Engineering	Elective	3	0	0	3
2	14M14MA432	Optimization and Statistical Methods	Elective	3	0	0	3
3	14M14ME433	Advanced Metrology and Computer Aided Inspection	Elective	3	0	0	3

- The research work in Dissertation Part I is continued in Dissertation Part II.
- The evaluation of dissertation Part II is done on the basis of the work done in both the semesters.

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1	14M11ME111	Analysis and Design of Machine Tools	Core	3	0	0	03
2	14M11ME112	Metal Machining	Core	3	0	0	03
3	14M11ME113	Casting and Welding	Core	3	0	0	03
4	14M11ME114	Unconventional Manufacturing Processes	Core	3	0	0	03
5	14M17ME172	Metal Machining Lab	Core	0	0	2	01
6	14M17ME173	Casting and Welding Lab	Core	0	0	2	01
7		DE –-I	Elective	3	0	0	03
		Total		**15**		**4**	**17**
List of Electives for DE-I to be updated from time to time			**Core / Elective**	**L**	**T**	**P**	**Credits**
1	14M14ME131	Industrial Inspection and Quality Control	Elective	3	0	0	3
2	14M14ME132	Quality Engineering	Elective	3	0	0	3
3	14M14ME133	Tool and Die Design	Elective	3	0	0	3

Course Description

Title of Course: Analysis and Design of Machine Tools **Course Code: 14M11ME111**
L-T Scheme: 3-0 **Course Credits: 3**

Course objective:

1. To develop competency in understanding of machine tools and its working principles.
2. To make the student conversant with design of machine tool structures and special features of machine tool design.
3. To develop the understanding of mechanical vibration, Static and dynamic testing of machine tools, Modal analysis, Vibration isolation.

Learning Outcome:

1. Students will be able to understand the design considerations for special features in Machine tools.
2. Students will be able to understand the effect of vibration on life of machine tools
3. Students will be able to analysis and design the machine tools structures.

COURSE CONTENT

Introduction to machine tools, principle of working of machine tools, concepts of design of machine tools.

DESIGN OF MACHINE TOOL

Design of Machine tool drives, Design of Kinematic Schemes of Machine Tools, Design of kinematic schemes used in modern machine tools drives, Design and Analysis of Machine Tool Structures, Columns, Beds, Spindles, Slide ways and Bearings, Newer concepts of design in CNC Machine tools.

VIBRATION IN MACHINE TOOLS

Machine Tool Vibrations, different theories of vibration in machine tools, Static and dynamic testing of machine tools, Modal analysis, Vibration isolation.

Text Books:

1. N.K. Mehta, Machine Tool Design, Tata McGraw Hill.
2. Bhattacharya and S. G. Sen., Principles of Machine Tool, New central book agency Calcutta.
3. D. K Pal and S. K. Basu, Design of Machine Tool, 4th Edition. Oxford & IBH Publishing Pvt. Ltd.

Reference Books:

1. G. Boothroyd, and W.A. Knight, Fundamentals of machining and machine tools, Taylor & Francis, Third edition.

Course Description

Title of Course: Metal Machining **Course Code: 14M11ME112**
L-T Scheme: 3-0 **Course Credits: 3**

- To study the basics of metal machining and mechanics of metal machining
- To study the different cutting tool materials and types & geometry of cutting tools
- To learn introductory concepts of various advanced machining processes

Learning Outcomes:

- The students have learned the basics of metal machining
- The students have also studied the introductory concepts of various advanced machining processes

COURSE CONTENT

Mechanics of Metal Cutting, Thermal Aspects of Machining.
Cutting fluids, Tool Wear, Tool Life.
Machinability, Economics of Machining.
Abrasive Processes, Vibrations in Cutting.
Introduction to Modern Machining Processes.

Text Books:

1. G. K. Lal (2007), Introduction to Machining Science, New Age International Publisher, New Delhi.
2. **A. Ghosh** and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
3. V.K. Jain (2005), Advanced Machining Processes, Allied Publishers Private Limited, India.

Reference Books:

1. P.C. Pandey and H. S. Shan (1996), Modern Machining Processes, TMH Publishing Limited, New Delhi.
2. R.K Jain (2005), Production Technology, Khanna Publisher, New Delhi.
3. S. Kalpakjian and S. Schemid (2001), Manufacturing, Engineering and Technology, Addison Wesley.

Course Description

Title of Course: Casting and Welding **Course Code: 14M11ME113**
L-T Scheme: 3-0 **Course Credits: 3**

Scope and Objective:

- To understand basic manufacturing processes like casting and welding
- To learn various aspects of different manufacturing techniques such as various casting methods and welding methods
- To have a broad knowledge to design a casting process for a product and design of welded joints

Learning Outcome:

In foundry technology the student will have a broad knowledge of sand casting: Pattern making: requirement of pattern materials, different pattern materials and designing of the pattern; Moulding and core making: Moulding sand, sand conditioning, moulding and core making processes and machines and special moulding methods; permanent mould casting: requirement of permanent mould casting, design requirement of permanent moulds and types of permanent mould casting; designing of gating system and risers, cupola furnace and defects in metal casting.

A brief knowledge on solid solutions, phases, phase equilibrium, phase diagram, phase transformation, heat treatment processes, cupola furnace and solidification in casting will be there.

In welding technology students will have a generalized knowledge on various welding technology used in manufacturing. They are going learn about arc welding processes, resistance welding, gas welding and brazing processes. In arc welding they are going to learn about the welding arc, arc welding power source, arc welding consumables and metal transfer. Also they are going to learn about shielded metal arc welding, submersed arc welding, gas tungsten arc welding, gas metal arc welding, electro-slag welding, electro-gas welding, resistance welding, oxy-acetylene welding and brazing processes.

COURSE CONTENT

Casting:

Mechanism of Solidification: Design Principles of Gates, Runners and Risers.

Design of Casting, Introduction to ferrous and non-ferrous foundry practice.

Iron-Carbon Equilibrium Diagram, TTT Curves, Heat treatment of Metals, Melting Furnaces

Recent developments in Casting. Casting defects, Inspection and testing of Castings.

Welding:

Theory of fusion and pressure welding, flow and distribution of heat in welding, Weldability, Welding of various materials, Non conventional welding processes

TEXT BOOKS:

1. Jain P L, Principles Foundry Technology, Tata McGraw Hill
2. Parmar R.S., Welding Process and Technology, Khanna Publishers.

REFERENCES:

1. Pandey P. C. and Singh C. K., Production Engineering Sciences, Standard Publisher.
2. De Garmo, E. P., Black, J. T. and Kohser, R.A., Materials and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd.
3. Ghosh A. and Mallik A. K., Manufacturing Science, EWP Pvt. Ltd.
4. William D. Callister and David G. Rethwisch, Materials Science and Engineering: An Introduction, Wiley

Course Description

Title of Course: Unconventional Manufacturing Processes **Course Code:14M11ME114**
L-T Scheme: 3-0 **Course Credits: 3**

SCOPE AND OBJECTIVES

- To make acquainted the various unconventional manufacturing processes
- To know about the applications of advanced manufacturing processes (which are exceptional)
- To encourage the students for developing the models (experimental/theoretical) of Advanced Manufacturing Processes

LEARNING OUTCOMES: Students will be able-

- To categorized the various unconventional manufacturing process based on energy sources and mechanism employed
- To select the best suitable advanced manufacturing process for processing of unconventional materials employed in modern manufacturing industries
- To study the parametric influences during processing of materials using developed models

COURSE CONTENT

Introduction to Unconventional Manufacturing Processes

Modern Machining Processes: Classification, Selection, Mechanics, Design, Economics, Accuracy and applications of modern mechanical, Thermo-electric, Chemical and electro-chemical machining processes like AGM, AWJM, USM, EDM, EBM, LBM, PAM, IBM, ECM, ECG, CHM, etc. Introduction to Hybrid Machining process.

High Velocity Forming Process: Explosive forming processes, Propellant forming, Gas forming, Electrohydrolic forming, Electromagnetic forming, Pneumatic/mechanical forming, Formability criteria.

TEXT BOOKS-

1. Benedict G.F., Non Traditional Manufacturing Processes, Marcel Dekker.
2. Ghosh and Mallik, Manufacturing Science, EWP Private Ltd.
3. Jain V. K., Advance Machining Processes, Allied Publisher.
4. Pandey P. C., Modern Machining Processes, TMH Publication.

REFERENCES:

1. El-Hofy, H., Advanced Machining Processes-Non-traditional and Hybrid Machining Processes, McGraw-Hill, NewYork.
2. McGough J. A., Advanced Methods of Machining, Chapman and Hall Ltd., London.
3. Kochan D., Solid Freeform Manufacturing, Elsevier Science.
4. Groover M.P., Fundamentals of Modern Manufacturing Processes, Prentice Hall.
5. Chryssolouris, G., Laser Machining - Theory and Practice (Mechanical Engineering Series), Springer - Verlag, NewYork.

Course Description

Title of Course: Metal Machining Lab **Course Code: 14M17ME172**
L-T-P Scheme: 0-0-2 **Course Credits: 1**

Scope and Objectives:

- To determine the shear plane angle and shear strain during the cutting of single point cutting tool of mild steel sheet
- To study the different cutting tool materials and types & geometry of cutting tools
- To learn introductory concepts of roughness during the metal cutting

Learning Outcomes:

- The students have determined the shear plane angle and shear strain during the cutting of single point cutting tool of mild steel sheet The students have also studied the introductory concepts of various advanced machining processes
- The students have made single point cutting tool as per given tool signature

Contents:

S.No.	Name of Experiments
1.	Determine the shear plane angle and shear strain of a work piece on shaper
2.	To determine the roughness in a specimen
3.	Optimization of current to overcome the taper obtains during EDM drilling process
4.	To study the geometry of single point cutting tool
5.	To prepare single point cutting tool as per given tool signature

Books:

1. R.K Jain (2005), Production Technology, Khanna Publisher, New Delhi.
2. A. Ghosh and A. K. Malik (2010) Manufacturing Science, East West Press Private Limited New Delhi.
3. G. K. Lal (2007), Introduction to Machining Science, New Age International Publisher, New Delhi.

Course Description

Title of Course: Casting and Welding Lab **Course Code: 14M17ME173**
L-T-P Scheme: 0-0-2 **Course Credits: 1**

Scope and Objective:

1. To study different testing methods for silica sand, moulding sand and design of pattern
2. To study SMAW, GMAW, GTAW, Oxy-acetylene welding and resistance spot welding processes

Learning Outcome:

In this lab the students will learn the requirement of different testing of moulding sand and design of pattern for a casting. They are going to learn GFN test, Moisture content test, Clay content test, Permeability test, Tensile and Compression strength test. And they are going to learn the design of pattern and manufacturing the designed pattern and use that pattern to get a casting for the designed one.

In welding techniques they are going to learn various safety aspects in welding. After that they will start learning different welding processes like SMAW, GMAW, GTAW, Oxy-acetylene welding and Resistance spot welding. In those processes they are going to learn the welding process, their compatibility, limitations and developments in them.

CONTENTS

S No	Name of Experiment
1	To design a wooden pattern for casting of cast iron
2	Making a wooden pattern designed in Experiment No. 1.
3	Preparing butt joint of two steel plates using manual Metal Arc Welding (MMAW)
4	Preparing lap joint of steel plates using Oxy Acetylene Gas welding.
5	To cut steel sheets of different thicknesses with the help of an oxy-acetylene gas cutting torch
6	To determine the hardness of Heat Affected Zone produced by welding and cut steels using oxy acetylene flame by Rockwell hardness tester.

TEXT BOOKS:

1. Jain P L, Principles Foundry Technology, Tata McGraw Hill
2. Parmar R.S., Welding Process and Technology, Khanna Publishers.

REFERENCES:

1. Rao P. N., Manufacturing Technology I, Tata McGraw Hill.
2. Jain R.K., Production Technology, Khanna Publisher.
3. Kalpakjian S., Schemid S., Manufacturing, Engineering and Technology, Addison Wesley.

Course Description

Title of Course: Industrial Inspection and Quality Control **Course Code: 14M14ME131**
L-T Scheme: 3-0 **Course Credits: 3**

SCOPE AND OBJECTIVE:

Induatrial inspection and quality control is a collection of tools that when used together can result in process stability and variance reduction. Objective of course is

1. Satisfactory level of quality must be achieved with a minimum cost
2. Eliminating assignable (special) sources of variation product outcome, so that the process is stable.
3. Monitoring the ongoing production process, assisted by the use of control charts, to detect significant changes of mean or variation.

LEARNING OUTCOME:

1. Understand the role of statistical tools in quality improvement and Inspection of industrial process & products.
2. Understand the different types of variability, rational subgroups, and how a control chart is used to detect assignable causes.
3. Construct and interpret control charts for variables such as *x-bar*, *r*, *s*, and individuals charts and understand concept of TQM, ISO 9000.

COURSE CONTENT

Quality

Concept of Quality, Quality Function, Quality Traits, Quality Characteristics, Quality Management, Quality Principles, Quality Policy, Quality System, Quality Planning, Organizing for Quality, Quality of Design, Quality Circles.

Inspection

Definition of Inspection, Inspection Planning, Measurement Errors, Objectives of Inspection, Floor / Patrol Inspection, Centralized Inspection, Process Inspection, Final Inspection, Difference between Inspection & Quality Control. Quality Assurance Importance, Total Quality Assurance, Management Principles in Quality Assurance, Forms of Quality Assurance, Evaluation of Quality Assurance, Quality Assurance Programme, Quality Assurance Aspects, Quality Assurance Departments.

Quality Control

Total Quality Control, Objectives of Quality Control, Principles of Quality Control, Quality Control Tools, Statistical Quality Control, Control Charts, Construction of Control Charts for Variables and Attributes (p, np, C, U Charts), Acceptance Sampling by Attributes, AOQ & OC Curves, Types of Sampling Plans, Analysis of Process Capability, Use of Dodge Roming and Military Standards Sampling Tables.

Quality Management System

Quality Management systems- origin of ISO 9000 series (ISO 9001,9002,9003,9004) ISO 9001:2000, clauses of ISO 9001:2000, overview of QS 9000 series.

Text Book

1. D.C. Montgomery, Introduction to Statically quality control, John Wiley & Sons, Inc.
2. A.M. Badhade, Metrology and Quality control

Reference Books

1. Suganthi, L and Samuel, A Anand , TOTAL QUALITY MANAGEMENT , Phi Learning Pvt. Ltd.
2. R. P. Mohanty, TOTAL QUALITY MANAGEMENT, Jaico

Course Description

Title of Course: Quality Engineering **Course Code: 14M14ME132**
L-T Scheme: 3-0 **Course Credits: 3**

Objectives:

1. To introduce the concept of total quality management
2. To introduce the different quality standards
3. To study about sampling and process control techniques
4.

Outcomes:

1. The students have learned the different introductory concepts of total quality management.
2. They have also studied different sampling and process control methods.

COURSE CONTENT

Quality and quality assessment – concept of Total Quality Management - Total Quality pioneers – Deming's philosophy – Juran's contributions – Crossby's contributions – quality and competitiveness – leadership concepts – Total Quality tools – customer satisfaction and translating need into requirements – employee involvement – continuous process improvement – customer-supplier partnership – quality cost concept – quality management – quality systems – ISO 9000 certification.

Quality Function Deployment - House of Quality – adding other factors to the House of Quality. Bench marking – approaches to benchmarking. Product design – reliability goals – system reliability – design for safety – design for manufacturability – error proofing – failure mode and effect analysis – FMEA documentation. Quality circles , motivation theories. Taguchi's quality engineering – concept of loss function – robust design. Concept of Total Productive Maintenance

Statistical Process Control – control charts for variables – process capability – control charts for attributes special control charts – process control and quality improvement – pursuit of decreased process variability

Sampling Plans ad Quality Assurance – acceptance sampling – economics of inspection – operating characteristic curve – parameters affecting acceptance sampling plans – types of sampling plans - characteristics of a good sampling plan – acceptance quality level – Dodge-Romig sampling tables – ATI and AFI – acceptance sampling by variables – selection of proper sampling procedures.

Text Book:

1. K. C. Arora, Toatl Quality Management, Khanna Publisher, New Delhi, 2007.
2. AmitavaMitra, Fundamentals of Quality Control and Improvement (English) 3rd Edition, Wiley India Pvt Ltd, 2007.

Reference Books:

1. L. Suganthi and Anand A. Samuel, Total Quality Management, PHI Learning Private Limited, 2009.
2. Peter Harriott, Process Cantrol, Mcgraw Hill Education, 2002

Course Description

Title of Course: Tool and Die Design **Course Code: 14M14ME133**
L-T Scheme: 3-0 **Course Credits: 3**

Scope and Objectives:

1. To know different reference systems used in single point tools, drill bits and milling cutters.
2. To know the forces in different tools while material removal or plastic deformation on the job.
3. To select proper material for the design of the tool and dies and to design of those as per the requirements.

Learning Outcome:

In this subject the students basically going to tool used in machining and dies in metal forming processes. In machining portion they are going to learn about geometry of cutting tool: ASA, ORS, NRS and WRS systems for a single point cutting tool and multipoint tools i.e. milling cutters. SRS, DRS and WRS for a twist drill and conversion equations from one system to the other; mechanics of machining: different forces in turning, milling and drilling, MCD for conversion of forces from one reference to the other and equipments used to measure forces in turning, milling, drilling and grinding processes; heat generation in machining: source, cause and effect of heat generation in machining; tool failure methods tool life and tool materials; types of chips and control of chip while machining using different possible chip breakers in the tools.

In design of different dies required in metal forming, a brief knowledge on metal forming will be established. According to requirement in the process the design considerations are to be taken and different dies are designed with proper selection of the die material.

COURSE CONTENT

Broad Classification of Tools-Cutting tools, Dies, Holding and measuring tools.

Design of Cutting Tools: Single Point and multi-pint cutting tools. Single Point Cutting Tools: Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design. Multipoint Cutting Tools: Classification and specification, nomenclature, Design of drills, milling cutters, broaches, taps etc. Design of Form Tools: Flat and circular form tools, their design and application.

Design of Dies: Classification of dies, Design of Dies for Bulk metal Deformation-Wire Drawing, Extrusion, Forging and Rolling; Design of Dies for Sheet metal: Blanking and Piercing, Bending and Deep-drawing; Design of Dies used for Casting and Moulding, Powder Metallurgy die design.

TEXT BOOKS:

1. Donaldson, Tool Design,Mcgraw Hill Education
2. Chattopadhyay A B, Machining and Machine Tools, Wiley India
3. Pandey P. C. and Singh C. K., Production Engineering Sciences, Standard Publisher

REFERENCES:

1. HMT, Production Technology, Tata McGraw Hill.
2. Serope Kalpakjian, Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education
3. Roy A. Lindberg, Materials and manufacturing technology, Allyn and Bacon

2 year M. Tech. Course Curricula for Manufacturing Technology							
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2	14M11ME212	Mechanics of Metal Forming	Core	3	0	0	03
3	14M11ME213	Additive Manufacturing Process	Core	3	0	0	03
4	14M11ME214	Mechatronics	Core	3	0	0	03
5	14M17ME271	Computer Integrated ManufacturingLab	Core	0	0	2	01
6	14M17ME272	Metal Forming Lab	Core	0	0	2	01
7		DE – II	Elective	3	0	0	03
		Total		**15**		**4**	**17**
List of Electives for DE-II to be updated from time to time			**Core/ Elective**	**L**	**T**	**P**	**Credits**
1	14M14ME231	Industrial Tribology	Elective	3	0	0	3
2	14M14ME232	Experimental Mechanics and Non-Destructive Testing	Elective	3	0	0	3
3	14M14ME233	Advanced Materials Technology	Elective	3	0	0	3

Course Description

Title of Course: Computer Integrated Manufacturing **Course Code: 14M11ME211**
L-T Scheme: 3-0 **Course Credits: 3**

Scope and Objectives

- This course introduces students with computer assisted modern manufacturing technologies.
- The topics covered in this course include basics of automation, NC programming (manual and APT), concepts of group technology, Flexible Manufacturing system, CIM and robotics.
- The objective of this course is to make students learn the important theoretical concepts, and the state-of-the-art technological developments in the area of modern manufacturing.

Learning Outcome

Student will be able to:

- understand the current status of CAM systems in the industry.
- learn the concepts of group technology, automation, FMS and CIM.
- to write APT and manual part programs using G and M codes for lathe and milling m/c.

COURSE CONTENT

Introduction: Automation, Need for Automation, Types of automation systems, Automation strategies, levels of automation, Introduction to NC, CNC and DNC and Computer integrated manufacturing, CIM wheel, components of CIM

Part programming: Introduction, NC coordinate system, fixed and floating zero machines, NC motion control systems, part programming methods, Manual part programming for milling and lathe using G and M codes, various canned cycles

Group Technology: part families, part classification and coding, production flow analysis, composite part concept, benefits of GT.

Flexible Manufacturing System: Definition of FMS, components of FMS, types of flexibilities, classification of FMS, primary and secondary material handling systems, FMS layout configurations, computer control system, FMS applications and benefits.

Automated Material Handling and AS/RS: Introduction, types of material handling equipment, automated guided vehicle system (AGVs), applications, vehicle guidance and routing, traffic control and safety system management, Basic components of AS/RS, types of AS/RS, AS/RS controls, special features

Robotics: Definition, robot anatomy and related attributes, robot configuration, work volume, types of control systems, end effectors, industrial applications of robot, introduction to robot programming.

Automated Inspection & Testing: Automated inspection principles, off-line and on-line inspection, contact and noncontact inspection techniques, Co-ordinate measuring machine (CMM): Introduction and types of CMM.

Manufacturing Support System: Product design and CAD, concurrent engineering and Computer aided process planning (CAPP).

TEXT BOOK:

1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
2. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall

REFERENCES:

1. Parrish D. J, “Flexible manufacturing”, Butterworth – Heinemann Ltd, 1990
2. Rao, P.N., CAD / CAM Principles and Applications, McGraw Hill Publishers, New Delhi
3. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.

Course Description

Title of Course: Mechanics of Metal Forming **Course Code: 14M11ME212**
L-T Scheme: 3-0 **Course Credits: 3**

Scope and Objectives:

- To analyse stress and strain at an inclined plane from the given three dimensional stresses.
- To understand theories of failures and to decide their application in the given situation.
- Forming load estimation during different metal forming processes.

Learning Outcome:

- Students will be able to solve the numerical problems to calculate stresses on inclined planes.
- Student will be able to apply theory of failure for the given process.
- Student will estimate the working loads for pressing, forging, wire drawing etc. processes.

COURSE CONTENT

Analysis of Stress and Strain, General Equations of Elasticity, Plastic deformations, Theories of Plasticity.
Modeling Techniques: slip line slab, Upper Bound and FEM.
Mechanics & Analysis of Manufacturing Processes: Rolling, Forging, Wire Drawing, Extrusion, Deep Drawing, Bending and other miscellaneous forming operations.
Analysis of Die failure in Metal Forming.Strain, Strain rates and thermal effects in metal forming.

TEXT BOOK:

1. Dieter George E.,Mechanical Metallurgy, McGraw-Hill, 1988.
2. Timoshenko S.P., Strength of Materials. Advanced Theory and Problems, CBS Publishers and Distributors, New Delhi.

REFERENCE BOOK:

1. Hearn E. J., Mechanics of Material Vol. I & II, Butterworth-Heinemann Publication.
2. Gere J. M., Mechanics of Materials, Thomson Press.
3. Pytel A. and kiusalaas J., Mechanics of Materials, Thomson Press.

Course Description

Title of Course: Additive Manufacturing Process **Course Code: 14M11ME213**
L-T Scheme: 3-0 **Course Credits: 3**

Scope and Objectives

1. The objective of this first course on additive manufacturing (AM) to the PG students of Manufacturing Technology stream is to make the students aware of rapidly evolving and widely used technology.
2. It is aimed to make the students aware of the technology for conceptual modeling, prototyping and rapid manufacturing. It is also aimed to introduce reverse engineering (RE).
3. It is aimed to impart detailed knowledge of wide applications of AM in industry and society; and in particular, key applications of AM such as rapid tooling, medical AM and rapid manufacturing.

Learning Outcome

1. The student will be able to select between a subtractive and an AM process for a particular application. He or she will be able to select a particular AM process.
2. The student will be able to take a career in research or in advanced manufacturing, the AM being a rapidly evolving area and with wide applications.
3. It is aimed at making the students ready for product development of engineering components and for entrepreneurship. He will be able to employ RE for value addition and reproduction of parts.

COURSE CONTENT

INTRODUCTION

Prototyping, rapid prototyping, Additive Manufacturing (AM), Process chain of additive manufacturing, Advantages of AM.

CLASSIFICATION OF AM PROCESSES

Liquid based, solid based, and powder based AM processes; Stereolithography and other liquid based systems, Fused Deposition processes for polymers, ceramics and metals, Laminated Object Manufacturing , Shape Deposition Manufacturing, Laser sintering based technologies, 3D printing, Direct Metal Deposition, LENS, Electron beam melting based process.

APPLICATIONS OF AM

Introduction, applications of AM in different categories such as conceptual design, rapid manufacturing, rapid tooling, terrain modeling, medical AM and mass customization (most of things to be discussed in detail in the chapters on Rapid Manufacturing, Medical AM and Rapid Tooling).

RAPID MANUFACTURING

Different applications of AM for directly making end-use parts – industrial applications, utilizing porous property, medical applications such as dental, hearing aid and medical devices, terrain modeling, transport, military, architectural, electronics, etc. Mass customization – production of customized products in mass scale.

MEDICAL AM

Medical applications of AM for prosthesis and implant; tissue engineering; complex surgical planning and visualization of bio-molecules with several case studies in each category.

6. DATA EXCHANGE FORMATS

Data formats for AM and associated details, Data conversion for AM and associated difficulties, Data validity checks for AM, Data repair procedures for AM, Slicing algorithms and related details, Direct slicing, Standard data formats for translation, Relevant AM file formats, STEP data format and its details.

RAPID TOOLING (RT)

Soft tooling and hard tooling, Direct methods of rapid tooling, Indirect methods of rapid tooling processes.

INTRODUCTION TO REVERSE ENGINEERING

Definition of Reverse Engineering (RE), Need for RE, Three phases in the generic RE process – scanning (contact and non-contact scanners), point processing and geometric modeling.

TEXT BOOKS:

1. Chua, C K, Leong, K F and Lim CS, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2003.
2. Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, New York, 2010.

REFERENCES:

1. Prasad, Hari and Badrinarayan, K.S., *Rapid Prototyping and Tooling*, ISBN: 978-81-923-2065-6, 1st edition, SIP-Page Turners Publications, Surya Infotainment Products Pvt. Ltd., Bangalore, 2013.
2. Hopkinson, N, Hague, R, and Dickens, P, *Rapid Manufacturing: An Industrial Revolution for a Digital Age: An Industrial Revolution for the Digital Age*, Wiley, Jan 2006.
3. Castle Island Co., *Worldwide Guide to RP*, available at: www.additive3d.com.
4. Hilton, P.D. and Jacobs, P.F., *Rapid Tooling – Technologies and Industrial Applications*, Marcel Dekker AG, Basel, Switzerland, 2000.
5. Gibson, Ian, *Advanced Manufacturing Technologies for Medical Application – Reverse Engineering, Software Conversion and Rapid Prototyping*, John Wiley and Sons Ltd, West Sussex, England, 2005
6. Raja, V. and Fernandes K.J., *Reverse Engineering – An Industrial Perspective*, Springer-Verlag London Ltd, 2008.
7. Kamrani, A.K. and Nasr, E.A., *Rapid Prototyping – Theory and Practice*, Springer Science and Business Media Inc., New York, NY 10013, USA, 2006.
8. Bartolo, P J (editor), *Virtual and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping*, Taylor and Francis, 2007.
9. Patri K. Venuvinod and WeiyinMa;*Rapid Prototyping - Laser-based and Other Technologies*, Kluwer Academic Publishers, October 2003.
10. Cooper K. G., *Rapid Prototyping Technology: Selection and Application*, CRC Press.

Course Description

Title of Course: Mechatronics **Course Code: 14M11ME214**
L-T Scheme: 3-0 **Course Credits: 3**

Course objective:

1. To develop an ability to identify, formulate, and solve engineering problems.
2. To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
3. To develop ability to Integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.

Learning outcomes:

1. Students will be able to model and analyze electrical and mechanical systems and their interconnection.
2. Students will be able to integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
3. Students will be able to demonstrate knowledge of electrical circuits and logic design.

COURSE CONTENT

Introduction To Mechatronics System: Key elements-Mechatronics Design Process-Types of Design-Traditional and Mechatronics Designs-Advanced Approaches in Mechatronics-Real Time Interfacing – Elements of Data Acquisition System.

Actuators, Sensors & Transducers: Fluid Power and Electrical Actuators-Piezoelectric Actuator; Sensors for position, motion, force and temperature-Flow sensors-Range sensors-Ultrasonic sensors-Fibre Optic Sensors-Magnetostrictive transducer-Selection of Sensors.

Signals, System & Controllers: Introduction to Signals, system and Controls-System representation-Linearisation-Time Delays-Measures of System performance; Closed loop Controllers-PID Controller, Digital Controllers-Controller tuning, adaptive Control-Introduction to Microprocessors, Micro-controllers and Programmable Logic Controllers-Components-PLC programming.

Advanced Applications in Mechatronics: Sensors for Condition Monitoring-Mechatronics Control in Automated Manufacturing-Artificial Intelligence in Mechatronics-Fuzzy Logic Application in Mechatronics-Microsensors in Mechatronics-Case Studies of Mechatronics Systems.

Text Books:

1. K.P. Ramachandran., G.K. Vijayaraghvan and M.S. Balasundram, Mechatronics: Integrated mechanical electronics system, Willey India Edition.
2. David G. Alciatore and Michel BiHistand, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill Publishing, Third edition.
3. G.S. Hegde, Mechatronics, Jones & Bartlett learning, 2010.

Reference Books:

1. W. Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, Pearson publication, fourth edition.

Course Description

Title of Course: Computer Integrated Manufacturing Lab **Course Code: 14M17ME271**
L-T-P Scheme: 0-0-2 **Course Credits: 3**

Scope and Objectives

- This course is designed to provide practical experience to the students with an opportunity of hands-on training on modern CNC machines and CIM system.
- The topics covered in this course include the basics of automation, NC programming (Manual and APT), concepts of group technology, Flexible Manufacturing system, CIM and robotics etc.
- The objective of this course is to expose the students to practical aspects of automation and the state-of-the-art technological developments in the area of modern manufacturing.

Learning Outcome

After completion of this course, the students will have:

- Knowledge and operational experience of CNC lathe and milling part programming.
- Knowledge and operational experience of programming for robots and CMM
- Capability to comprehend the functioning of various components of the automation and CIM.

COURSE CONTENT

XL Turn Machine

1. Write a manual part program for Linear and Circular Contour (G01, G02, and G03) operation for the component.
2. Write a manual part program for Box Facing (G94) operation for the component.
3. Write a manual part program for Multiple Facing (G72) operation for the component.
4. Write a manual part program for Multiple Turning operation with G71 Cycle for the component.
5. Write a manual part program for Peck Drilling operation with G74 Cycle for the component.
6. Write a manual part program for Turning and Parting OFF operation through subroutines for the component.

XL Mill Machine

7. Write a manual part program for Contouring (G01, G02, and G03) operation (Linear & Circular Interpolation) for the component.
8. Write a manual part program for Contouring (G40, G41) operation with Left cutter diameter compensation for the component.
9. Write a manual part program for Contouring (M98, M99) operation through subprogram for the component.
10. Write a manual part program for Mirroring (M70, M71, M80, and M81) operation for the component.
11. Write a manual part program for Drilling (G73, G83, G98, and G99) operation for the component.
12. Write a manual part program for Pocketing (G170, G171) operation for the component.

5-axis and 6-axis Robot

13. Write a program for pick and place operation for 5-axis robot
14. Write a program for continuous welding operation for 6-axis robot

Coordinate Measuring machine (CMM)

15. Write a program for automatic measurement of various dimensions such as OD, ID, thickness etc. of a part.

Complete CIM System

16. Demonstration and study of CIM system Off-line manual mode.
17. Demonstration and study of CIM system on-line automatic mode

TEXT BOOK:

1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
3. CNC XLTURN Manual by MTAB, Chennai
4. CNC XLMILL Manual by MTAB, Chennai
5. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall

REFERENCES:

6. Parrish D. J, “Flexible manufacturing”, Butterworth – Heinemann Ltd, 1990
7. Rao, P.N., CAD / CAM Principles and Applications, McGraw Hill Publishers, New Delhi
8. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.

Course Description

Title of Course: Metal Forming Lab **Course Code: 14M17ME272**
L-T-P Scheme: 0-0-2 **Course Credits: 3**

Scope and Objectives:

- To learn the precautions and steps to operate universal testing machine.
- To perform Erichsen Cupping test on the sheet metal and appreciate the flow of metal during cupping.
- To calculate the springback of sheet metal during bending.

Learning Outcome:

- Student will be operate universal testing machine.
- Student will perform the cupping test and will study the flow pattern.
- Student will calculate the spring back of metal.

CONTENTS

Sr. No.	Name of Experiment
1.	To study the UTM and perform the tensile test on given specimen
2.	To perform compression test on UTM.
3.	To study the effects of material properties (ductility, types, strength) on the springback and bending force.
4.	To compare formability of sheet metals using Erichsen Cupping test.

Course Description

Title of Course: Industrial Tribology **Course Code: 14M14ME231**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives:

- To acquaint students' in all aspects of materials science, surface science, applied physics and mechanical engineering which relate directly to the subjects of wear and friction.
- To enhance students' knowledge regarding theory of lubricants, physical properties, various theories of lubrication and its standards.
- To give the idea of various types of hydrostatic and hydrodynamic bearings and their working principles.

Learning outcome:

Upon successful completion of this course student would have learnt:

- About surface interaction of solid bodies, the theory of friction, types of friction, friction mechanisms, and friction characteristics of various materials subjected to various extreme condition and thermal considerations between contacting surfaces in sliding motion.
- About complete theory of lubricants, physical properties, various theories of lubrication and its standards.
- About design and performance analysis of fluid film bearings of both hydrostatic and hydro dynamic bearings.

COURSE CONTENT

Introduction – Basic equations – NavierStoke's equations – Derivation of Reynolds equation from NavierStoke's equations – Energy equation, Idealised hydrodynamic bearings – Mechanisms of pressure development – Plane slider bearings – Idealized journal bearing – Infinitely long and Infinitely short bearings.

Finite Bearings – Performance characteristics – Numerical solutions – Hydrodynamic instability– Bearing design – Analysis of externally pressurized and gas lubricated bearings.

Surface interactions, surface topography, roughness measurements, Hertzian contacts, Real area of contact, Theories of friction, Friction of metals, Friction of non-metals, Temperature of sliding surfaces, Stick-slip, Rolling friction.

Wear of metals, Adhesive wear, Abrasive wear, Corrosion and corrosion wear, erosion, Fatigue and impact wear, Wear of elastomers, Wear of ceramics and composite materials, Measurement of friction and wear, Introduction to Nanotribology.

TEXT BOOKS:

1. Engineering Tribology by PrasantaSahoo, PHI Learning, New Delhi, 2009

2. Fundamentals of Tribology by S.K. Basu, S.N. Sengupta, B.B. Ahuja, PHI Learning, New Delhi, 2012

REFERENCES:

1. Lubrication: a tribology handbook by E. Neale, CBS Publishers & Distributors, New Delhi, 1993

2. Nanostructured coatings by Albano Cavaleiro, Springer-Verlag, Berlin Heidelberg, 2006

Course Description

Title of Course: Experimental Mechanics and Non-Destructive Testing **Course Code: 14M14ME232**

L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives-

- To study about the experimental concepts in solid mechanics.
- To make the students acquainted with the various non-destructive methods of inspection.
- To make them familiar with various methods for measuring applied forces and displacements.

Learning Outcomes: Students will be able-

- To know the point wise displacement measurements (e.g., strain gage) and applications of wave optics to materials research
- To learn about the transducer applications (e.g. LVDT, Strain gages, capacitive gages, piezoelectric elements).
- To understand the working procedure of different non-destructive testing techniques for application.

COURSE CONTENT

Experimental Mechanics: Photo-elastic techniques of analysis for two dimensional and three dimensional problems.

Interferometry, Holography, Moire fringe and their application in stress analysis, strain gauges and transducers, brittle coatings, techniques of motion measurement.

Modern NDE methods of flaw detection, Ultrasonic testing, Liquid penetrate testing, X-ray radiography, Magnetic particle testing, Current testing, Acoustic Emission Testing.

TEXT BOOKS:

1. Ravi Prakash, Nondestructive Testing Techniques, *New Age Science*, 2009.
2. Mohammad Omar, Ed, Nondestructive Testing Methods and New Applications, InTech, 2012.
3. Baldev Raj, C V Subramanian, T Jayakumar, Non Destructive Testing of Welds, Alpha Science International, Limited, 2000.

REFERENCE BOOKS

4. Chuck Hellier, Handbook of Nondestructive Evaluation, Second Edition, McGraw-Hill Professional, 2012.
5. Louis Cartz, Nondestructive Testing: Radiography, Ultrasonics, Liquid Penetrant, Magnetic Particle, Eddy Current, ASM International, 1995.
6. Paul E. Mix, Introduction to Nondestructive Testing: A Training Guide, Second Edition, Wiley, 2005.

Course Description

Title of Course: Advanced Materials Technology **Course Code: 14M14ME233**
L-T Scheme: 3 **Course Credits: 3**

Course objective:

1. Primary objective is to present the basic fundamentals of failures of the materials.
2. Help students to possess a solid foundation in advanced materials with emphasis on the fundamental engineering principles that govern the properties, processing and their applications.
3. To apply the different methods or techniques in improving the properties of materials.

Learning outcomes:

1. Students will be able to compile about the properties, structure of ceramic materials and their need for newer applications and processing techniques.
2. Students will be able to express the different fabrication techniques, how the properties are improved after they are processed with different methods.
3. Students will be able to demonstrate the need for newer materials by comparing the limitations of conventional materials.

COURSE CONTENT

Review of Mechanical Behavior of Materials: Plastic deformation in poly phase alloys - Strengthening mechanisms - Griffith's theory of failure modes – Brittle and ductile fractures - Damping properties of materials - fracture toughness - Initiation and propagation of fatigue cracks - Creep mechanisms - Hydrogen embrittlement of metals.

Surface Modification of Materials: Mechanical surface treatment and coating - Case hardening and hard facing - thermal spraying – vapour deposition-ion implantation - Diffusion coating - Electroplating and Electroforming - Conversion coating - Ceramic and organic coatings – Diamond coating - Advanced surface modification of steels.

Advanced Heat Treatment of Materials: Unconventional surface hardening techniques-Heat treatment of critical mechanical elements like gears, tools, dies, springs, shafts-Heat treatment of Al, Cu, Ni and Ti alloys-Polymerquenchants.

Modern Materials and Alloys: Super alloys-Refractory materials-Ceramics and their applications-Low melting alloys-shape memory alloys-Metal matrix and ceramic matrix composites.

Applications of Advanced Materials: Ti and Ni based alloys for gas turbine applications-Maraging and Cryogenic steels-Newer materials and their treatment for automobile applications-Materials for Naval and nuclear systems.

Text Books:

1. E Paul Degarmo, J T Black, Ronald A Kohser., Materials and Processing in Manufacturing, Willey Publication, 2006
2. Composite Materials Hand book – M M Schwartz, McGraw Hill.
3. G.E. Totten., Steal heat treatment handbook- Metallurgy and Technologies, CrC press, Taylor and Francis group, second edition.

Reference Books:

1. P K Mallick., Fiber Reinforced Composites- Materials, Manufacturing and Design, CRC press, Taylor and Francis group.
2. Metal Matrix Composites – Minoru Taya, Richard J Arsenault

2 year M. Tech. Course Curricula for Manufacturing Technology							
M. Tech. III semester (M3)							
S. No.	**Subject Code**	**Subject**	**Core/ Elective**	**L**	**T**	**P**	**Credits**
1		DE– III	Elective	3	0	0	03
2		DE – IV	Elective	3	0	0	03
3	14M19ME391	Seminar I	Core	0	0	4	02
4	14M19ME392	Dissertation Part I*	Core	0	0	24	12
	* to be continued in Semester IV						
		Total		**6**	**0**	**28**	**20**
List of Electives for DE-III & DE-IV to be updated from time to time			**Core/ Elective**	**L**	**T**	**P**	**Credits**
DE-III							
1	14M14ME331	Hydraulic and Pneumatic Control System	Elective	3	0	0	3
2	14M14ME332	Micro-Fabrication	Elective	3	0	0	3
3	14M14ME333	Robotics and Automation	Elective	3	0	0	3
4	14M14ME334	Operations and Supply Chain Management	Elective	3	0	0	3
5	15M14ME338	Modelling and Optimization Techniques in Engineering	Elective	3	0	0	3
DE-IV							
1	14M14ME335	Laser Beam Machining	Elective	3	0	0	3
2	14M14ME336	Advanced Composite Materials	Elective	3	0	0	3
3	14M14ME337	Computer Aided Design and Drafting	Elective	3	0	0	3

Course Description

Title of Course: Hydraulic and Pneumatic Control System **Course Code: 14M14ME331**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives:

- To acquaint students about the various sources of hydraulic and pneumatic power
- To know about the hydraulic and pneumatic control devices and components
- To familiarize students about the pneumatic and fluid power circuits

Learning outcome:

Upon successful completion of this course, students will learn about:

- The fundamentals of pneumatic and hydraulic systems and their components
- The concepts of pneumatics and fluidics, PLC's, their applications and designing circuits with those components

COURSE CONTENT

Introduction to oil hydraulics and pneumatics, their advantages and limitations.ISO Symbols and standards in Oil Hydraulics and Pneumatics.Recent developments, applications Basic types and constructions of Hydraulic pumps and motors.Ideal pump and motor analysis. Practical pump and motor analysis, Performance curves and parameters.

Hydraulic control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve analysis and Design. Analysis of valve controlled and pump controlled motor. Electrohydraulic servo valves – specification, selection and use of servo valves. **Electro hydraulic servomechanisms** – Electro hydraulic position control servos and velocity control servos. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Basic configurations of hydraulic power supplies – Bypass Regulated and Stroke Regulated Hydraulic Power Supplies.Heat generation and dissipation in hydraulic systems.Design and analysis of typical hydraulic circuits. Use of Displacement – Time and Travel-Step diagrams; Synchronization circuits and accumulator sizing. Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits.

Components of a pneumatic system; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits; Valves for logic functions; Time delay valve; Exhaust and supply air throttling; Examples of typical circuits using Displacement – Time and Travel-Step diagrams.Will-dependent control, Travel dependent control and Time-dependent control, Combined Control, Program Control, Sequence Control, Electro-pneumatic control and air-hydraulic control.Applications in Assembly, Feeding, Metalworking, materials handling and plastics working.

TEXT BOOKS:

1. Introduction to hydraulics and pneumatics by S. Ilango and V. Soundararajan, PHI Learning, New Delhi, 2nd Edition, 2009
2. Hydraulics and Pneumatics by A. K Upadhyay, S. K. Kataria& Sons, New Delhi

REFERENCES:

1. Fluid Power Control: Hydraulics and Pneumatics by Ahmed Abu Hanieh, Cambridge International Science Publishing
2. Pneumatic and Hydraulic Systems by W. Bolton, Butterworth-Heinemann Ltd, 1997

Course Description

Title of Course: Micro-fabrication **Course Code: 14M14ME332**
L-T Scheme: 3 **Course Credits: 3**

Objectives:

1. To introduce the different materials used for micro fabrication.
2. To introduce the different methods of micro-fabrication.
3. To study about the different tools of micro-fabrication.

Outcomes:

1. The students have studied the different materials used for micro fabrication.
2. They have also studied tools of micro-fabrications.

COURSE CONTENT

Introduction,Micrometrology and Materials Characterization, Simulation of Microfabrication processes, Materials: Silicon, Thin Film Materials and Processes, Epitaxy, Thin-film Growth and Structure.

Basic Processes: Pattern Generation, Optical Lithography, Lithographic Patterns, Etching, Wafer Cleaning and Surface Preparation, Thermal Oxidation, Diffusion, Ion Implantation, Chemical-Mechanical Polishing, Bonding and Layer Transfer, Moulding and Stamping.
Structures: Self aligned structures, Plasma etched structures, Wet-etched silican structures, Sacrificial and Released structures, Structures by Deposition. Integration: Process Integration, CMOS Transistor Fabrication, Bipolar Technology, Multilevel Metallization, MEMS Process Integration, Processing on Non-silicon substrates.
Tools: Tools for Microfabrication, Tools for Hot Processes, Vacuum and Plasmas, Tools for CVD and Epitaxy, Integrated Processing. Manufacturing: Cleanrooms, Yield, Wafer Fab.

Text Books:

1. Sami Franssila, Introduction to Micro-Fabrication, John Wiley & Sons Inc., 2003.
2. Shrestha Surendra, Fundamental of Micro/Nano Fabrication, Scholars' Press, 2004.

Reference Books:

1. Stephen A. Campbell, Fabrication Engineering at the Micro- And Nanoscale, Oxford University Press, USA, 2001.

Course Description

Title of Course: Robotics and Automation **Course Code: 14M14ME333**
L-T Scheme: 3 **Course Credits: 3**

Scope and objective:

- To introduce the basic concepts, parts of robots and types of robots.
- To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
- To discuss about the various applications of robots, justification and implementation of robot.

Learning outcome: Student will be able to:

- To explain the basic principles of Robotic technology, configurations, control and programming of Robots.
- Design an industrial robot which can meet kinematic and dynamic constraints.
- To describe the concept of Robot kinematics and dynamics, latest algorithms & analytical approaches
- To discuss and apply the concepts of dynamics for a typical Pick and Place robot.
- To choose the appropriate Sensor and Machine vision system for a given application.
- To explain the basic principles of programming and apply it for typical Pick & place, loading & unloading and palletizing applications.

COURSE CONTENT

Fundamentals of Automation: Strategies and economics, Principles of automation applied to loading feeding, measuring, material handling, storage, assembly, process control and quality control.

Industrial Robots: Technology, programming and applications, Manufacturing systems: Transfer machines, conventional machine layout systems, flow line systems, machining centres, NC, DNC and CNC systems.

Flexible Manufacturing Systems, Introduction, Production, materials handling and management sytems in FMS.

Group Technology: Classification procedures and coding systems, Layout planning model for GT, materials requirement planning and computer aided process planning. Introduction to Computer - Integrated Manufacturing systems, Factories of the future and Social impacts.

Robot Technology:- Physical configuration, Drives (Hydraulic, Pneumatic, Electrical), Basic motors, Sensors including vision, Technical features, Programming languages, Work cell control Robot sensors, Robot applications**.**

TEXT BOOKS:

1. Deb S. R. and Deb S., “Robotics Technology and Flexible Automation”, Tata McGraw Hill Education Pvt. Ltd, 2010.
2. John J.Craig , “Introduction to Robotics”, Pearson, 2009.
3. Mikell P. Grooveret. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
4. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.

REFERENCES BOOKS:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics : Control, Sensing, Vision and Intelligence", McGraw Hill, 198
3. Handbook of Industrial Robotics edited by Shimon Y.
4. Robotics: Designing the Mechanisms for Automated Machinery by Ben-Zion Sandler.

Course Description

Title of Course: Operations and Supply Chain Management **Course Code: 14M14ME334**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives:
Operation and Supply Chain Management applied successfully in many different areas of engineering, production and business activities for better & scientific decision making.
Role of Operations and Supply Chain Management

1. Better control on operations and supply chain system
2. Better coordination among the organizations departments
3. Better decisions and quantitative decision.

Learning Outcome:
Students will able to

1. Identify and develop operational models from the verbal description of the real System or supply system .
2. Understand the mathematical tools that are needed to solve optimization and forecasting of operations and supply system problem
3. Develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision making processes in operation and supply chain management.

CONTENTS
FORECASTING: Introduction, different methods of forecasting, errors in forecasting
FACILITY LAYOUT AND LOCATION: Introduction, different models of layout, decision making
CAPACITY AND AGGREGATE PLANNING
Capacity measurement, long-term and short term strategies, aggregate planning
INVENTORY MANAGEMENT
Various costs in inventory management and need, deterministic models and discounts, probabilistic inventory management
SCHEDULING MODELS AND APPLICATIONS
Scheduling in MRP system, sequencing rules and applications, batch production sequencing and scheduling .
INTRODUCTION TO SUPPLY CHAIN
Definition, complexity, key issues, centralized vs. decentralized systems, bullwhip effect, push-based, pull based systems
OUTSOURCING AND TRANSPORTATION: Make or buy decisions, drivers of the decisions, network design decisions, cross-docking, and transshipment

DISTRIBUTION AND LOGISTICS IN SUPPLY CHAINS.
Direct shipment/intermediate storage policies, vehicle routing models, third-party logistics
INFORMATION TECHNOLOGY IN SUPPLY CHAIN
Enabling supply chain through IT, ERP vendor platforms, Service oriented architecture (SOA), RFID

Text Book

1. Supply Chain Management by *Chopra and Meindl*
2. Operations research by Sharma J.K., Trinity press

References:

1. Operations Management by *Evans and Collier*
2. Operations Management by *Heizer and Render*
3. Supply Chain Management by *Janat Shah*

Course Description

Title of Course: Laser Beam Machining **Course Code: 14M14ME335**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives

- To make acquainted the various types of lasers, applications of lasers and generation of laser
- To understand mechanisms of material removal in laser beam machining (LBM) process
- To encourage the students for doing research in the area of LBM

Learning Outcomes: Students will be able-

- To select the best suitable laser for processing of different workpiece materials
- To study the parametric influences during LBM process
- To understand the theoretical model of LBM process

COURSE CONTENT

Overview of Machining Processes

Introduction, Conventional Machining Processes, Nonconventional Machining Processes.

Lasers for Machining

Light and Laser – Historical background, Basic Mechanisms in Lasers, Laser Light: Properties, Generation of laser beam, Classification, Laser Equipment Characteristics and application of lasers, Lasers in engineering.

Basics of Laser Machining

Laser processing of materials and process capabilities, Laser Machining as a One, Two and Three – Dimensional Process, Laser Machining Systems, Laser Machining Control, Economics of Laser Systems.

Heat Transfer and Fluid Mechanics for Laser Machining

Introduction, Fundamentals of Heat Transfer, Conduction, Convection and Fluid Mechanics, Radiation, Numerical Methods in Heat Transfer and Fluid Mechanics (Basic Concepts, Finite Difference Method, Finite Element Method).

Laser Beam Machining

Laser processing of materials and process capabilities, Laser beam machining (LBM), Process principle, Laser Micromachining.

Laser Machining Analysis and Applications

Introduction, Problem Definition for Laser Process Modeling (Drilling, Cutting, Grooving, 3-D Machining), analysis and applications of laser Drilling, Cutting, Turning, and Milling processes.

Text Books

1. Mc-Gough J. A., Advanced Methods of Machining, Chapman and Hall Ltd, 1988.
2. Jain V. K., Advanced Machining Processes, Allied Publishers, 2002.
3. Pandey P. C., Modern Machining Processes, Tata McGraw Hill, 1980.

References:

1. Steen W. M., Laser Material Processing, Springer, 2003.
2. Luxton J.T., Parker D.E, Industrial lasers and their applications, Prentice Hall, 1987.
3. Chryssolouris G., Laser Machining- Theory and Practice (Mechanical Engineering Series), Springer, 1991.

Course Description

Title of Course: Advanced Composite Materials **Course Code: 14M14ME336**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives:

- To explain the fundamental concepts of mechanical behavior of conventional and advanced composite materials.
- To explore the basic stress analysis techniques used to determine the material properties such as the modulus of elasticity and the Poisson's ratio.
- To explain the isotropic and anisotropic composite material behavior.

Learning Outcome: Students will be able-

- To identify the properties of fiber and matrix materials used in commercial composites.
- To evaluate function and performance of composites using stress, strain and stiffness tensors and ideas from matrix algebra.
- To create and design engineering structures and projects associated with fibre-composites.

COURSE CONTENT

Fibers and matrices, various composites, Fiber-matrix interface properties, Unidirectional laminates, Cross- plied laminates, Multi-directional laminates, Various geometrical aspects of laminates.

Elastic properties of uni-directional lamina, Random long fiber lamina, Short fiber composites, Stress-strain distribution at fibre ends, Thermal stresses and curing stresses, Laminate theory, Strength of uni-directional laminate, Strength of short fiber composites, Edge effect in angle ply laminates.
Fatigue, Notch sensitivity and fracture energy of composites, Failure modes of fiber composites, Energy absorbing mechanism of fiber composites, Property degradation due to various environmental conditions, Manufacturing techniques of composites, Current and potential applications of composites.

TEXT BOOKS-

1. Srinivasan. K, Composite materials: production properties testing and applications, Narosa Publishing House, 2009.
2. Hull, D. and Clyne, T.W., Introduction to composite materials, Cambridge University press, 1996.

REFERENCE BOOKS-

1. Bunsell, A, R. and Renard, J., Fundamentals of fiber reinforced composite materials, Institute of Physics Pub, 2005.
2. Gibson, Ronald F., **Principles of composite material mechanics,** CRC Press (Taylor & Francis Group), 2012.
3. Barbero, Ever J., Introduction to composite materials design, CRC Press (Taylor & Francis Group), 2011.
4. Louis A. Pilato and Michael J. Michno, Advanced composite materials, Springer-Verlag Berlin Heidelberg GmbH, 1994.

Course Description

Title of Course: Computer Aided Design and Drafting **Course Code: 14M14ME337**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives

- The objective of the course is to impart the mathematical elements of CADD to the students.
- It is aimed at making the students aware of the 2D and 3D transformations of objects for display and data exchange formats for CAD and CAM.
- It is aimed at imparting fundamentals of design of curves, surfaces and solid models to the students.

LEARNING OUTCOME

- The student will be able to design geometric features of an object on a computer, display it on the screen and interact with it with a pointing device.
- The student will understand the fundamentals of plane and space curves, surfaces and solid models and will be able to apply in design and analysis of engineering components.

COURSE CONTENT

Computer aided design: The design process and the role of CAD, Types of design model, Application of design models, CAD system architecture.

Defining the Model: Computer representation drawing and diagrams, Three dimensional wire frame modeling scheme, solid modeling. Techniques of geometric modeling: Representation of Curves, parametric representation of geometry, Bezier curves, Cubic spline, B-spline, Rational curves, Techniques of Surface modeling Volume modeling.

Interactive Graphics: Hardware, Two dimensional vector graphics, Three dimensional computer graphics, Techniques for visual realism: hidden line removal, surface removal Entity manipulation and data storage: manipulation of model, object transform, mirror transformation,Data Structure and Interactive Modeling, Object oriented representation, Database, Database consideration Applying the CAD Model in design.

Text Books:

1. Zeid, Ibrahim, *CAD/CAM Theory and Practice*, McGraw-Hill, Inc.
2. Rogers, David F. and Adams, J. Alan, *Mathematical Elements for Computer Graphics*, McGraw-Hill Publishing Company.

Reference Books:

1. Mortenson, Michael E., *Geometric Modeling*, John Wiley & Sons.
2. Foley, J.D., van Dam, A., Feiner, S.K. and Hughes, J.F., *Computer Graphics: Principles and Practice*, Pearson Education.
3. Rooney, J. and Steadman P., *Principles of Computer-aided Design*, Affiliated East-West Press Pvt Ltd.
4. Hearn, Donald and Baker, M. Pauline, *Computer Graphics*, Prentice Hall of India.

Course Description

Title of Course: Modelling and Optimization Techniques In Engineering **Course Code: 15M14ME338**

L-T Scheme: 3 **Course Credits: 3**

Scope and Objective:

- To learn the importance of Modelling in Process industries
- To study the steps in the formulation of a Mathematical Model
- To learn about the various optimization techniques

Learning outcome:

Upon successful completion of this course student should be able to:

- Develop optimization models for real case industrial problems
- Explore the various types of optimization techniques to solve the real case problems
- Implement the hybrid and meta- heuristics in order to model and solve the engineering problems

COURSE CONTENT

INTRODUCTION

Need for Modelling and Optimization of Manufacturing Processes, Modelling and Optimization, Types of Modelling and Optimization, Design Variables, Constraints, Objective Function, Problem formulation, Single and Multi-objective optimization methods, constrained optimization methods.

DESIGN OF EXPERIMENTS (DOES)

Introduction to DOE processes- factorial design, fractional factorial design: two levels and three level design.

RESPONSE SURFACE METHODOLOGY (RSM)

Introduction to RSM, Steepest ascent method, central composite design (CCD), Box-Behnken design, central composite rotatable design (CCRD).

TAGUCHI METHOD (TM)

Selection of control factors and levels, parameter design, degree of freedom, selection of orthogonal array (OA), types of characteristics, signal-to-noise (S/N) ratio, analysis of variance (ANOVA), confirmation of result.

Statistical regression techniques, fitting of regression models, Grey relational analysis (GRA), Principal component analysis (PCA), Fuzzy Theory, Artificial Neural Network (ANN).

META-HEURISTICS

Genetic algorithms, Simulated Annealing, Tabu search, Particle Swarm Optimization, Ant colony Optimization and Bee Algorithms.

HYBRID APPROACHES

TMRSM, RSMGA, Taguchi-Fuzzy based approach, GRA-fuzzy, Neuro-fuzzy, NSGA.

TEXT BOOKS:

1. Montgomery, D.C. (1997) *Design and Analysis of Experiments*, New York: John Wiley.
2. Deb, K., "Optimization for Engineering Design", Prentice Hall of India, 1995.

REFERENCES:

1. Klir GJ, Yuan B. Fuzzy sets and fuzzy logic (theory and applications). Third Ed. New Delhi: Prentice Hall of India; 2005.
2. Haykin, S. (2002), Neural Networks, a Comprehensive Foundation, 2nd Edition, Pearson Education Pte. Limited: Delhi, India.
3. Roa, S.S., "Optimization Theory and Application", Wiley Easter, 1984.
4. Phadke, M.S. (1989) *Quality Engineering Using Robust Design*, NJ: Prentice-Hall, Englewood Cliffs

Course Description

Title of Course: Seminar I **Course Code: 14M19ME391**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objective:

- To promote the professional development of graduate students and their ability to formulate a problem/hypothesis.
- To improve their presentation and communication skills.
- To prepare students for the method of literature survey, realization of journal papers outcomes, expose them to the world of research and compilation/review of a research area of current era and prepare them for presentation of literature summary.
- Presentation on advanced topics in the field of Mechanical Engineering.

Learning outcome

Student will be able to:

- To prepare students for the method of literature survey, realization of journal papers outcomes, expose them to the world of research and compilation/review of a research area of current era and prepare them for presentation of literature summary.

Expectation from the students in Seminar I:

- Each student will choose a broad topic in consultation with his/her supervisor on which he/she will give presentation. Seminar-I is a course requirement where in under the guidance of a faculty member, a student is expected to do in depth study in a specialized area by doing literature survey and understanding different aspects of the problem. The Seminar-I is an independent course, not related to Dissertation Part-I.
- The researcher is expected to give clear and concise oral presentations in the three evaluations.
- Finally a report of the work done or state-of-the-art-report in the specialized area is to be submitted towards the end of the semester.

Course Description

Title of Course: Dissertation Part I **Course Code: 14M19ME392**
L-T Scheme: 3 **Course Credits: 3**

Objective: The objective of Dissertation Part-I is to promote a systematic understanding of the knowledge, critical awareness of current problems, originality in the application of knowledge and the quality of work. The ideal work may be characterized by a new result in design, development and implementation. It should have the potential of industrial/scientific acceptance.

The first part of the Dissertation should be to determine the interest of students and broadly identify the area of work, finalize the research problem based on literature survey. Also, by now the students should have familiarity with the concepts, tools, techniques required to carry out the Dissertation work. Student is expected to start the research work. Outcome of Dissertation Part-I should be to conclude the work on the identified problem its importance, its justification, literature survey, field work, research work etc. Minor variation may be accepted depending upon nature of title.

Guidelines:

- Each student will decide his Dissertation topic in consultation with his/her supervisor on which he/she will work towards the fulfillment of Master's Dissertation.
- In the first mid-term seminar, the researcher will present a literature review and define the problem.
- In the final viva-voce, the researcher is expected to give the problem formulation in detail. By the end of the first semester of the dissertation, the experimental techniques, analysis and/or synthesis procedure should come out clearly. Progress of the work should also be presented. The viva-voce will be based on your work, thesis report and presentation
- Finally a report will be submitted towards the end of the semester.

2 year M. Tech. Course Curricula for Manufacturing Technology							
M. Tech. IV semester (M4)							
S. No.	**Subject Code**	**Subject**	**Core/ Elective**	**L**	**T**	**P**	**Credits**
1		DE – V	Elective	3	0	0	03
2		DE – VI	Elective	3	0	0	03
3	14M19ME491	Seminar II	Core	0	0	4	02
4	14M19ME492	Dissertation Part II*	Core	0	0	28	14
		Total		**6**	**0**	**32**	**22**
List of Electives for DE-V & DE-VI to be updated from time to time			**Core/ Elective**	**L**	**T**	**P**	**Credits**
DE-V							
1	14M14ME431	Finite Element Analysis	Elective	3	0	0	3
2	14M14CL452	Environmental Engineering	Elective	3	0	0	3
3	14M14CI132	Artificial Intelligence in Manufacturing	Elective	3	0	0	3
DE-VI							
1	14M14ME432	Concurrent Engineering	Elective	3	0	0	3
2	14M14MA432	Optimization and Statistical Methods	Elective	3	0	0	3
3	14M14ME433	Advanced Metrology and Computer Aided Inspection	Elective	3	0	0	3

Course Description

Title of Course: Finite Element Analysis **Course Code: 14M14ME431**
L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives:

- The main objective of this subject is to provide a practical training in engineering design using finite element methods. When components have complex construction, shape, and general boundary conditions (loading and restraint) the designer will often use finite element methods to determine their structural integrity.
- The first half of the module aims at introducing the fundamental principles of the modeling for statics and dynamics analyses.
- In the second half of the module the student's will be taught how to use the method in practice and to critically assess and evaluate the results. The module aims to provide an introduction to this important stress analysis technique, and by way of case studies shows how it may be used to design components.

Learning Outcome:

By the end of the module the student should be able to...

- Recognize the significance and importance of finite element methods to the professional design engineer.
- Provide a theoretical understanding on the fundamentals of finite element methods for small displacement linear elastic analysis.
- Provide experience on how to develop good models and how to interpret the numerical results in design.

CONTENT

Introduction – Basic concepts – steps involved in finite element analysis – Variational methods of approximation – Galerkin's method – shape functions – Family of elements – Assembly and solution techniques – One dimensional problems.

Analysis of scalar field problems and vector field problems – Finite element analysis of fluid mechanics and heat transfer problems – Heat conduction – Energy and Navier stokes equations.

Elasticity problems – Two and three dimensional elasticity problems – Bending of beams – The Euler – Bernoulli beam element, Plane stress and Euler – Bernoulli element – bending of elastic plate – classical plate model – Shear deformable plate model – Finite element.

Eigen value and time dependent problems – Formulation of Eigen value problems – Time dependent problems – Applications – Non-linear problems – Finite element error analysis – Automatic mesh generation.

TEXT BOOKS:

- Finite Element Analysis by P. Seshu

REFERENCES:

- Finite Element Method for Engineering by C.V. Girija Vallabhan
- The Finite Element Method for Engineers by Kenneth H. Huebner

Course Description

Title of Course: Environmental Engineering **Course Code: 14M14CL452**
L-T Scheme: 3 **Course Credits: 3**

Objective
The objective of this course is to give the students a basic idea of the different types of pollution in the environment. This course also gives them the idea about how to handle environmental pollution problems.

LEARNING OUTCOMES
After completion of this course the students will be able to handle pollution control problems.

Description
The Multidisciplinary nature of environmental studies: Definition, scope and importance, Need for public awareness, Types of Ecosystems, World Biomes, Ecosystem functioning, Biogeochemical cycles. Natural resources, their consumption & Protection: Water, Land Energy (Renewable, non-renewable, wind, solar, hydro, Biomass), Mineral, Forest, & Food resources, Role of an individual in conservation of natural resources, Equitable use of resources.

Pollution- a threat to environment: Air, Water & Land pollution, sources & causes, Space pollution, causes & effects, toxicity limits of pollutants. Critical issues concerning global Environment (Urbanization, population growth, global warming, climate change, acid rain, ozone depletion etc.) and the Roots in: Cultural, Social, Political, Commercial, industrial, territorial domains.

Biodiversity loss: Diversity of flora and fauna, species and wild life diversity, Biodiversity hotspots, threats to biodiversity.

Environmental Impact assessment: Objectives of impact assessment, Study of impact parameters, Methods for impact identification, Economics. Environmental standards & Quality: Air, Water & Soil Quality, Pollutant sampling, pollution control systems.

Sustainable building, Urban planning, Disaster Management and Contingency Planning, Modern safety systems.

Sustainability & Planned reversal of human destruction to environment: redevelopment of brown fields, energy plantations, social forestry, engineering aspects of Re-use & Recycling, biogas for marginal income groups, organic farming, eco-consumerism, dematerialization, green technologies, eco-tourism.

Regulation of technology and innovation, Policy and law: Environmental Laws & Regulations (Different Acts – Environmental Protection Act, Air and Water Acts, Wildlife and Forest Acts), US-EPA, National Environmental Policy; Function of pollution control boards (SPCB and CPCB), their roles and responsibilities, Eco-mark Scheme, Laws relating to Urbana and Rural land use, Ethics

Case studies: Industry – Environment interface, Field Work: Explore the surrounding flora & fauna (Study of common plants, insects, birds document environmental assets), documentation of industries in local region and their possible effects, measure of water, air and land quality, Visit to a local polluted site-Urban/Rural /Industrial / Agricultural, Study of simple ecosystems-pond, river, hill slopes etc

Recommended Text books:

1. Joseph, B., 2005, Environmental Studies, Tata McGraw Hill, India.
2. Textbook of Environmental Studies for UG Courses - ErachBharucha, University Press

Reference Books

1. Nebel, B.J. & Wright, R.T., 1993, Environmental Science, 8th Edition, Prentice Hall, USA.
2. Jadhav, H. &Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284p.

3. Chiras D D.(Ed.). 2001. Environmental Science – Creating a sustainable future. 6th ed. Jones &Barlett Publishers.
4. David Laurance. 2003. Environment Impact assessment, Wiley publications.
5. Chhokar KB, Pandya M &Raghunathan M. 2004. Understanding Environment. Sage publications, NewDelhi
6. Non-ConventionalEnergyResources – Chauhan, DS. and Srivastava, SK, New Age International Pvt. Ltd

Other suggested material:

1. Issues of the journal: Down to Earth, published by Centre for Science and Environment
2. Audio visuals from: Discovery, National Geographic etc.
3. Rachel Carson 1960. Silent springs

Course Description

Title of Course: Artificial Intelligence in Manufacturing **Course Code: 14M14CI132**
L-T Scheme: 3 **Course Credits: 3**

Objectives:
This course gives the basic knowledge artificial intelligence in manufacturing like robotics which is useful for fast manufacturing. This course gives the basic knowledge of components of an intelligence system, their functions, mechanisms, policies and techniques used for fast manufacturing.

Learning Outcomes:
The students will have a detailed knowledge of the concepts of artificial intelligence. Various application of AI in different fields.Aware of a variety of approaches to AI techniques.

Course Content:

UNIT 1: Introduction:
Artificial Intelligence - Definition - Components - Scope - Application Areas; Knowledge - Based Systems (Expert Systems) - Definition - Justification - Structure – Characterization.

UNIT 2: Knowledge Sources:
Knowledge Sources - Expert - Knowledge Acquisition - Knowledge Representation - Knowledge Base - Interference Strategies - Forward and Backward Chaining.

UNIT 3: Expert System Languages: Expert System Languages - ES Building Tools or Shells; Typical examples of Shells. Expert System software for manufacturing applications in CAD, CAPP, MRP, Adaptive control.

UNIT 4: Robotics, Process control, Fault diagnosis, Failure Analysis; Process Selection, GT etc. Linking expert systems to other software such as DBMS, MIS, MDB.

UNIT 5: Case Study
Process control and Office automation. Case studies of typical applications in tool selection, Process selection, Part classification, and inventory control, Process Planning etc.

Text Books:

1. Rich, Elaine Knight, Kevin , Artificial Intelligence, Tata McGraw Hill.
2. Luger, George F, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education.

References:

1. Nilsson, Nils J , Artificial Intelligence, Morgan Kaufmann
2. Russell, Stuart J. Norvig, Peter , Artificial Intelligence: A Modern Approach, Pearson Education
3. Negnevitsky, Michael , Artificial Intelligence: A Guide to Intelligent Systems, Addison - Wesley.
4. Andrew Kussiak, “Intelligent Manufacturing Systems”, Prentice Hall , 1990
5. Badiru A.B., “Expert Systems Applications in Engineering and Manufacturing”, Prentice-Hall, New Jersey, 1992.
6. Liu, Dikai, Wang, Lingfeng, Tan, Kay Chen (Eds.) Design and Control of Intelligent Robotic Systems, Springer-Verlag, London. ISBN 978-3-540-89932-7
7. Rao R. V. “Advanced Modeling and Optimization of Manufacturing Processes”,Springer-verlag, London. ISBN 978-0-85729-014-4

Course Description

Title of Course: Concurrent Engineering **Course Code: 14M14ME432**

L-T Scheme: 3 **Course Credits: 3**

Scope and objectives:

1. To make them familiar with the role of indirect features that affect the manufacturing process and quality of the product.
2. To make them acquainted with the basic techniques for enhancing the productivity and customer satisfaction.

Learning outcomes:

Students will be able to

1. Students will be able to understand the basic fundamentals of concurrent engineering and the various techniques used for implementation of it.

COURSE CONTENT

Introduction

Fundamentals of concurrent engineering, Need and basic principles of concurrent engineering, Benefits of implementation of concurrent engineering, Introduction to various integrating mechanisms, Forming of concurrent engineering team, Interfacing of manufacturing and design, Selection of key techniques and methodologies, Selection of concurrent engineering tools.

Quality By Design

Quality function deployment methodology, Taguchi methods of robust design.

Design For Manufacturability

Virtual manufacturing, Introduction to value engineering, Value engineering analysis and techniques, Design for assembly: Introduction to various DFA technologies.

Rapid Prototyping

Need and use of rapid prototyping, various rapid prototyping technologies, Design for reliability, Reliability fundamentals and design for reliability principles, Design for serviceability, Factors affecting serviceability, Serviceability evaluation, Design for maintainability and economics, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

Text Books :

1. Concurrent Engineering- Kusiak - John Wiley & Sons
2. Concurrent Engineering- Menon - Chapman & Hall

Course Description

Title of Course: Optimization and Statistical Methods **Course Code: 14M14MA432**

L-T Scheme: 3 **Course Credits: 3**

Objectives:

1. To apply Integral transforms to solve differential equations and use this knowledge to solve engineering applications.
2. To know about various random life length models and their uses in finding the reliability of different electronic devices.
3. To learn about basic properties and characteristics of various random processes with reference to signal and trunk processes.

Learning Outcomes:

1. At the end of the course the student will have the background of Integral transforms necessary in analyzing and solving problems which occur in engineering.
2. Model life random processes using appropriate statistical distributions.
3. Compute the reliability of different stochastic systems and
4. Apply the knowledge of random processes in signal processing and trunking theory.

Course Content:

CALCULUS OF VARIATIONS:

Functional and externals, functional spaces, Euler equation, Natural boundary and transition conditions, Variation principle, General case of integral functional, Hamilton's principle, Lagrange's equations of motion, Generalized dynamical entities, Problems reducible of Lagrange problem, Externals with moving boundaries, Hamilton's principal for continuous media, Simple example of applications.

OPERATIONAL METHODS:

Integral transforms, Applications of transform calculus to partial differential equations and evaluation of integrals, Applications of operational calculus in solving linear differential equations with variable coefficients, Applications of integral transforms in solving initial valued and boundary valued problems.

STATISTICAL MODELS

Random Variables, Probability Distributions, Data Analysis, Estimation of Point and Confidence Interval, Regression Models, Analysis of Variance, Experimental Design.

TEXT BOOKS:

1. T. Veerarajan ,Probability, Statistics and Random Processes, Tata McGraw Hill.
2. Larry C. Andrews and B.K. Shivamoggi, Integral Transformations for Engineers, Prentice –Hall of India, New Delhi.

REFERENCE BOOK:

1. Raghuveer M. Rao and Ajit S. Bopardikar, Wavelet Trasforms: Introduction to theory and applications, Pearson Education (Indian Branch), Patparganj, Delhi.
2. Patrick J. Van Fleet, Discrete wavelet transformations: an elementary approach with applications, Wiley-Interscience, New Jersey.
3. LokenathDebnath and Dambaru Bhatta, Intgral Transforms and their applications, Chapman & Hall/CRC.
4. J.J. Aunon& V. Chandrasekhar, Introduction to Probability and Random Processes, Mc-Graw Hill International Ed.
5. A. Papoulis & S.U. Pillai, Probability, Random Varibles and Stochastic Processes, Mc- Graw Hill.
6. H. Stark, and J.M. Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education.

Course Description

Title of Course: Advanced Metrology and Computer Aided Inspection **Course Code: 14M14ME433**

L-T Scheme: 3 **Course Credits: 3**

Scope and Objectives:

Advanced Metrology and Computer Aided Inspection application can be seen in various areas of engineering. Its application we can see in mass production section, Automobile section.

Learning Outcome:

Upon successful completion of this course, the student will be able to:

(a) Operate the co-ordinate measuring machines.
(b) Operate the Laser Interferometry.
(c) Determining combined standard uncertainty.
(d) Know the algorithms and sampling methods used in data analysis, thermal and environmental effects.

COURSE CONTENT

Experimental Test Plan: Random Tests, Replication & repetition Uncertainty analysis: Type A and Type B, Determining combined standard uncertainty- Uncorrelated and correlated input quantities, reporting, conformity.

Surface Roughness Measurement: Stylus instruments, other techniques, Data acquisition and filtering, Amplitude parameters, Texture parameters, Surfaces in three dimensions. Form Evaluation: Instruments, Parameters, Algorithms.

Coordinate Measuring Machines: Construction, Operation & Programming, probing systems, probe and stylus, non contact sensors, probe calibration, error compensation of co-ordinate measuring machines, algorithms and sampling methods used in data analysis, thermal and environmental effects, compensation of probing errors. CMM Software, scanning, reverse engineers applications, performance evaluation of co-ordinate measuring machines.

Latest Developments: Machine Vision: Sensing, Preprocessing, Segmentation, Description, Recognition and Interpretation, Laser Interferometry, Nanometrology.

References:

1. ISO, “Guide to the expression of Uncertainty in Measurement”, 1995.
2. Figliola, Richard S, & Beasley, Donald E, “Theory and Design for Mechanical Measurements”, Third edition, John Wiley & Sons Inc,
3. Tom R Thomas, “Rough Surfaces 2nd ed”, Imperial College Press, London, 1999.
4. John A Bosch : Co-ordinate Measuring Machines and Systems – Marcel Dekker, Inc. 1995
5. S.Fu, R.C.Gonzalez, C.S.G.Lee, Robotics: Control, Sensing, Vision, and Intelligence, Chapters 7,8, pages 296-449 .

Course Description

Title of Course: Seminar II **Course Code: 14M19ME491**

L-T Scheme: 3 **Course Credits: 3**

Scope and Objective:

- To promote the professional development of graduate students and their ability to formulate a problem/hypothesis.
- To improve their presentation and communication skills.
- To prepare students for the method of literature survey, realization of journal papers outcomes, expose them to the world of research and compilation/review of a research area of current era and prepare them for presentation of literature summary.
- Presentation on advanced topics in the field of Mechanical Engineering.

Learning outcome

Student will be able to:

- To prepare students for the method of literature survey, realization of journal papers outcomes, expose them to the world of research and compilation/review of a research area of current era and prepare them for presentation of literature summary.

Expectation from the students in Seminar II:

- Each student will choose a broad topic in consultation with his/her supervisor on which he/she will give presentation. Seminar-II is a course requirement wherein under the guidance of a faculty member, a student is expected to do in-depth study in a specialized area by performing literature survey. He should analyze works of various authors/researchers critically, study concepts and techniques; and present it. The Seminar-II is an independent course, not related to Seminar I and Dissertation Part-II.
- The researcher is expected to give clear and concise oral presentations in the three evaluations.
- Finally a report of the work done or state-of-the-art-report in the specialized area is to be submitted towards the end of the semester.

Course Description

Title of Course: Dissertation Part II **Course Code: 14M19ME492**

L-T Scheme: 3 **Course Credits: 3**

Objective: The objective of Dissertation Part-I is to promote a systematic understanding of the knowledge, critical awareness of current problems, originality in the application of knowledge and the quality of work. The ideal work may be characterized by a new result in design, development and implementation. It should have the potential of industrial/scientific acceptance. Dissertation Part-II should be seen in continuation with Dissertation Part-I. The researcher should continue the research work in the two parts.

Guidelines:

- Each researcher should present analytical and/or experimental works in consultation with his/her supervisor towards the fulfillment of Master's degree.
- The researcher will present the progress of his work in the mid-semester evaluation.
- He/she will present his/her complete work including literature review and introduction. The evaluation will be done based on the work done in both the semesters. In the end-semester evaluation of 4^{th} semester, the researcher will present his/her research work and defend his/her dissertation.
- Finally a dissertation has to be submitted to the University for Partial Fulfillment of M. Tech. program according to university rules. The students have to submit one copy of the dissertation soft bound/spiral bound before the end-semester evaluation for external examiner to facilitate modification. They should submit three bound copies of the dissertation after the end-semester evaluation, one of which will go to the supervisor. Therefore, a student will get four copies bound (one copy for himself), if he/she has one supervisor. The no. of copies may increase, in case he/she has more than one supervisor.