E.G.S. PILLAY ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai Accredited by NAAC with „A" Grade | Accredited by NBA

NAGAPATTINAM – 611002

M.E. MANUFACTURING ENGINEERING

REGULATION -2024

First Year – First Semester

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	**2401MF101**	Probability and Statistics in Manufacturing	FC	3	1	0	4	4
2.	**2402MF102**	Modern Manufacturing Processes	PCC	3	0	0	3	3
3.		Program Elective – I	PCC	3	0	0	3	3
4.		Program Elective – II	PCC	3	0	0	3	3
5.	**2401RMX01**	Research Methodology andIPR	RMC	3	0	0	3	3
6.		Audit Course – I	AC	2	0	0	2	0
PRACTICALS								
7.	**2402MF103**	Computer Aided Manufacturing Laboratory	PCC	0	0	4	4	2
8.	**2402MF104**	Metal Forming and Metal Testing Laboratory	PCC	0	0	4	4	2
			TOTAL	**17**	**2**	**8**	**27**	**20**

PROGRAM ELECTIVE COURSES (PEC)
SEMESTER I, ELECTIVE – I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	**2403MF001**	Theory of Metal Forming	PEC	3	0	0	3	3
2.	**2403MF002**	Computer Aided Product Design	PEC	3	0	0	3	3
3.	**2403MF003**	Material Testing and Characterization	PEC	3	0	0	3	3
4.	**2403MF004**	Manufacturing Process Planning and Cost Estimation	PEC	3	0	0	3	3

SEMESTER I, ELECTIVE – II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	**2403MF005**	Micro System Technology	PEC	3	0	0	3	3
2.	**2403MF006**	Design of ManufacturingTools, Jigs and Fixtures	PEC	3	0	0	3	3
3.	**2403MF007**	Advanced WeldingTechnology	PEC	3	0	0	3	3
4.	**2403MF008**	Quality and ReliabilityEngineering	PEC	3	0	0	3	3

2401MF101 PROBABILITY AND STATISTICS IN MANUFACTURING L T P C
3 1 0 4

OBJECTIVES:

- To understand the basics of random variables with emphasis on the standard discrete andcontinuous distributions.
- To introduce the concepts of sampling distributions and the test statistics.
- To provide an understanding of the statistical methods and concepts by which real life problemsare analyzed.
- To analyze various data using statistical techniques.
- To train the students in design experiments and use these concepts for research.

MODULE I PROBABILITY THEORY 12

Random variables – probability density and distribution functions-moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications in manufacturing.

MODULE II SAMPLING THEORY 12

Sampling distributions – Standard error – t, F, Chi square distributions – applications in manufacturing.

MODULE III ESTIMATION THEORY 12

Interval estimation for population mean, standard deviation, difference in means, preparation ratio ofstandard deviations and variances- applications in manufacturing.

MODULE IV TESTING OF HYPOTHESIS AND ANOVA 12

Hypothesis testing – Small samples – Tests concerning proportion, means, standard deviations –Tests based on chi square – and Redistribution test -Design of experiments - applications in manufacturing.

MODULE V ANOVA 12

Design of experiments – One, Two factor Models- applications in manufacturing

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student will be

- Able to analyze the performance in terms of probabilities and distributions achieved by thedetermined solution.
- Aware of various test statistics for the samples.
- Able to develop an ability to apply statistical tests in experiments as well as to analyze andinterpret data.
- Able to use the statistical tools for their project and future research.
- Able to use the concepts in design of experiments in manufacturing problems.

REFERENCES:

1. Gupta and Kapoor, “Fundamentals of Applied Statistics”, Sultan Chand and sons, 4th Edition, NewDelhi, 2019.
2. Hooda, “Statistics for Business and Economics”, Macmillan, 3rd Edition, India, 2003.
3. John.E.Freunds, “Mathematical statistics with applications”, Pearson Education, 8th Edition, NewDelhi, 2013.
4. Levin and Rubin, “Statistics for Management”, Pearson Education India, 7th Edition, New Delhi,2013.

2402MF102 MODERN MANUFACTURING PROCESSES L T P C
3 0 0 3

OBJECTIVES:

- To create awareness on Abrasive aided machining
- To understand electrical and electrochemical machining processes.
- To analyse the principles of high energy aided machining.
- To study the surface and bulk machining processes of silicon wafer.
- To introduce students to the major manufacture steps in electronic circuit boards.

MODULE I ABRASIVE AIDED MACHINING PROCESSES 9

Abrasive machining – water jet machining - ultrasonic machining –Abrasive flow machining- Magnetorheological Abrasive flow machining- construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications .

MODULE II ELECTRICAL AND CHEMICAL AIDED MACHINING PROCESSES 9

Wire cut EDM - Electric discharge machining – Electrochemical machining – chemical machining – Maskants - Electrochemical grinding - construction – principle – types – control - circuits – tool design – merits, demerits and applications. Hybrid Machining.

MODULE III HIGH ENERGY AIDED MACHINING PROCESSES 9

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

MODULE IV FABRICATION OF MICRO DEVICES 9

Semiconductors – Si wafer - planarization – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process

MODULE V MICROFABRICATION TECHNOLOGY 9

Moulding – PCB board hybrid and MCM technology – programmable devices and ASIC – electronic material and processing– stereolithography – Solid free form fabrication -SAW devices, Surface Mount Technology

TOTAL: 45 PERIODS

OUTCOMES :

Students will be able to

CO1 : Understand and grasp the significance of modern machining process and its applications.
CO2 : Identify the selection of machining process and its parameters.
CO3 : Express and appreciate the cutting edge technologies and apply the same for researchpurposes.
CO4 : Measure the stages involved in fabrication of micro devices.
CO5 : Create new devices involved in micro fabrication and recent technology.

REFERENCES:

1. Brahem T. Smith, Advanced Machining I.F.S. UK 2016.
2. Jaeger R.C., Introduction to Microelectronic Fabrication Addison Wesley, 2nd Edition, 1998.
3. Jain V K, Micromanufacturing Processes, CRC Press, 2012.
4. Julian W. Gardner, Vijay K Varadan and Osama O Awadelkarim, Microsensors MEMS andSmart devices, John Willey, 2013.
5. Pandey P.C. and Shan HS Modern Machining Processes, Standard Publishing Co.,1st Edition,1980.
6. Serope Kalpakjian and Steven R. Schmid- Manufacturing Process for Engineering Material – Pearson Education, 6th Edition, 201

2401RMX01 RESEARCH METHODOLOGY AND IPR L T P C

3 0 0 3

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

MODULE I RESEARCH PROBLEM FORMULATION 9

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

MODULE II LITERATURE REVIEW 9

Effective literature studies approaches, analysis, plagiarism, and research ethics.

MODULE III TECHNICALWRITING /PRESENTATION 9

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

MODULE IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 9

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

MODULE V INTELLECTUAL PROPERTY RIGHTS (IPR) 9

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.

Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 45 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today‟s world is controlled by Computer, Information Technology, buttomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guidefor beginners” 2010

2402MF103 COMPUTER AIDED MANUFACTURING LAB L T P C
0 0 4 2

AIM:

To impart the knowledge on training the students in the area of CAM
To teach the students about programming of CNC machines
To train them to use the various sensors

EXPERIMENTS:

Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving& canned cycle
Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle.
Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Strain gauge, PLC, LVDT, Load cell, Angular potentiometer, Torque, Temperature & Optical Transducers.

TOTAL: 60 PERIODS

Equipment's List:

1. Computer System – 15 Nos
2. Drafting and Modeling Software – 15 Nos
3. CAM Software – 15 Nos
4. CNC Lathe – 1 No
5. CNC Milling – 1 No

OUTCOMES:

Students will be able to
CO1 : Understand and grasp the significance of modern machining process and itsapplications through hands-on experience.
CO2 : Identify the selection of machining processes and its process parameters.
CO3 : Express and perform project related works.

2402MF104 METAL FORMING AND METAL TESTING LABORATORY L T P C
0 0 4 2

AIM

- To impart practical knowledge on bulk metal forming and sheet metal forming processes

OBJECTIVE

- To train the students to have an hands on having the basic concepts of metal forming processes and to determine some metal forming parameters for a given shape.

EXPERIMENTS

1. Determination of strain hardening exponent
2. Determination of strain rate sensitivity index
3. Determination of efficiency in water hammer forming
4. Determination of interface friction factor
5. Study on rolling process
6. Determination of torque and force measurement in rolling mill.
7. Analysis of cutting forces on a lathe.
8. Measurement of torque on milling machine.

TOTAL: 60 PERIODS

Equipment's List:

1. Water Hammer Forming Equipment – 1 No
2. Universal Testing Machine – 1 No
3. Two High Roll Mill– 1 No
4. Hydraulic Press – 1 No
5. Wire EDM – 1 No
6. Pin on Disc Wear testing machine – 1 No
7. Fatigue Testing Machine – 1 No
8. Micro Hardness – 1 No

OUTCOMES:

Students will be able to

1. **CO1 :** Understand and grasp the significance of modern machining process and itsapplications through hands-on experience.
2. **CO2 :** Identify the selection of machining processes and its process parameters.
3. **CO3 :** Express and perform project related works.

PROGRAM ELECTIVE COURSES (PEC)
SEMESTER I, ELECTIVE – I

2403MF001 THEORY OF METAL FORMING L T P C
3 0 0 3

OBJECTIVES:

- To provide knowledge on the mechanism involved in plastic deformation and parameterrepresentation.
- Enable students to understand various bulk forming process and its recent technology.
- To provide overview of various sheet metal forming process
- To study the powder metallurgy techniques and Special metal forming processes.
- To introduce the significance of surface treatment and industrial application of metal forming

MODULE I THEORY OF PLASTICITY 9

Theory of plastic deformation – Yield criteria – Tresca and Von-Mises – Distortion energy – Stress- strain relation – Mohr,,s circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.

MODULE II THEORY AND PRACTICE OF BULK FORMING PROCESSES 9

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming.

MODULE III SHEET METAL FORMING 9

Formability studies – Conventional processes – High energy rate forming (**HERF**) techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application – Incremental forming.

MODULE IV POWDER METALLURGY AND SPECIAL FORMING PROCESS 9

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

MODULE V SURFACE TREATMENT AND METAL FORMING APPLICATIONS 9

Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging. Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimesof Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.

TOTAL: 45 PERIODS

OUTCOMES:

Students will able to

CO1 : Understand the state of stress in metal forming process.
CO2 : To identify the appropriate bulk forming process based on the application.
CO3 : Understand the conventional sheet metal forming process and various high energy rateforming techniques.
CO4 : Understand the powder metallurgy forming technique.
CO5 : Select appropriate surface heat treatment technique.

REFERENCES:

1. Altan T, Metal forming – Fundamentals and applications – American Society of Metals, Metals park,1983.
2. Helmi A Youssef, Hassan A. El-Hofy, Manufacturing Technology: Materials, Processes andEquipment, CRC publication press, 1st Edition,2017.
3. Marciniak Z, Duncan J.L, Hu S.J, Mechanics of Sheet Metal Forming, Butterworth-Heinemann,2nd Edition, 2002.
4. Nagpal G.R, Metal Forming Processes, Khanna publishers, 2005.
5. Shiro Kobayashi, Soo-Ik-Oh-Altan T, Metal forming and Finite Element Method, Oxford University Press,1989.
6. Surender kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers,1st Edition,2008.

2403MF002 COMPUTER AIDED PRODUCT DESIGN L T P C
3 0 0 3

OBJECTIVES:

- To review the basics of Computer aided design
- To familiarize students on use of modelling tools of CAD software.
- To apply the various design concepts and design tools and techniques while designing aproduct.
- To understand the product modelling method and its relationship with computer graphics.
- To create awareness on product life cycle management.

MODULE I INTRODUCTION 8

Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – CAD/CAM hardware andSoftwares – software packages for designand drafting.

MODULE II COMPUTER GRAPHICS FUNDAMENTALS AND GEOMETRIC 8

Computer graphics – applications – principals of interactive computer graphics – 2D 3D transformations – projections – curves - Geometric Modelling – types – Wire frame surface and solidmodelling – Boundary Representation, constructive solid geometry – Graphics standards – assembly modelling – use of software packages

MODULE III PRODUCT DESIGN CONCEPTS AND PRODUCT DATA MANAGEMENT 10

Understanding customer needs – Product function modelling – Function trees and function structures – Product tear down methods – Bench marking – Product portfolio – concept generation and selection – Product Data Management – concepts – Collaborative product design– manufacturing planning factor – Customization factor – Product life cycle management.

MODULE IV PRODUCT DESIGN TOOLS AND TECHNIQUES 10

Product modelling – types of product models; product development process tools – TRIZ – Altshuller,,s inventive principles – Modelling of product metrics – Design for reliability – design for manufacturability – machining, casting, and metal forming – design for assembly and disassembly - Design for environment

MODULE V PRODUCT DESIGN TECHNIQUES 9

FMEA – QFD – Poka Yoke - DOE – Taguchi method of DOE – Quality loss functions – Design for product life cycle.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the design phases and various design hardware and software.
CO2 : Relating basics of various geometrical feature creation.
CO3 : Systematically work on each stages in the development of a new product and its management.
CO4 : Predicting on various factors for various design applications.
CO5 : Mixing the techniques in the design of new product.

REFERENCES:

1. Biren Prasad, ―Concurrent Engineering Fundamentals Vol.II, Prentice Hall,1st Edition, 1996..
2. David F.,Rogers.J, Alan Adams, Mathematical Elements for Computer Graphics, McGraw Hill, 2nd Edition,2002.
3. Ibrahim Zeid, Sivasubraminian R, CAD/CAM theory and Practice, McGraw Hill, 2nd Edition, 2009.
4. James G.Bralla, Handbook of Product Design for Manufacturing, McGraw Hill,1998
5. Kevin Otto, Kristin Wood, Product Design, Pearson Education, 2004

2403MF003 MATERIAL TESTING AND CHARACTERIZATION L T P C
3 0 0 3

OBJECTIVES:

- To provide understanding of techniques of microstructure and crystal structure evaluation ofmaterials
- To introduce tools for analysis of microstructure and surface topography of materials.
- To understand the techniques of chemical and thermal analysis of materials.
- To gain knowledge in various static mechanical testing methods.
- To gain knowledge in various dynamic mechanical testing methods.

MODULE I MICRO AND CRYSTAL STRUCTURE ANALYSIS 9

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction
– Bragg„s law – Techniques of X-ray Crystallography
– Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction – Estimation of residual stress and grain size.

MODULE II ELECTRON MICROSCOPY 9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF and DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction and working of SEM and FESEM Back scattered and Secondary Electron Imaging Techniques – Applications- Atomic Force Microscopy- Construction and working of AFM - Contact and Non-Contact modes Applications.

MODULE III CHEMICAL AND THERMAL ANALYSIS 9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Energy dispersive and Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravity metric Analysis (TGA) - Dynamic Mechanical Analysis (DMA)

MODULE IV MECHANICAL TESTING – STATIC TESTS 9

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test, Rebound hardness and Indendation
– Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy and Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

MODULE V MECHANICAL TESTING – DYNAMIC TESTS 9

Fatigue – Low and High Cycle Fatigues – Rotating Beam and Plate Bending HCF tests – S-N curve
– LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests – Fatigue life estimation.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : To characterize the engineering materials.
CO2 : Know the fundamental principle of Top-notch characterization tools.
CO3 : Choose appropriate mechanical static testing methods.
CO4 : Choose appropriate mechanical dynamic testing methods
CO5 : Identify the crystal structure and analysis can be made.

REFERENCES:

2. Angelo P C, Material characterization, Cengage Learning India, 2016.
3. Cullity B.D., Stock S.R and Stock S., Elements of X ray Diffraction, 3rd Edition. Prentice Hall, 2018.
4. Skoog, Holler and Nieman, Principles of Instrumental Analysis, 7th edition, Cengage Learning, 2017.
5. Suryanarayana A. V. K., Testing of metallic materialism‟s publications, 2nd Edition, 2007.
6. Suryanarayana C, Experimental Techniques in materials and Mechanics, CRC Press, 1st Edition,2011.
7. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Hong Kong University Of Science And Technology, John Wiley and Sons (Asia) Pte Ltd., 2nd Edition, 2013.

2403MF004 MANUFACTURING PROCESS PLANNING AND COST ESTIMATION **L T P C 3 0 0 3**

OBJECTIVES:

- To introduce the concepts of manufacturing process planning.
- To familiarize the idea of cost accounting and information.
- To develop estimation skills in estimating material and labour cost.
- To introduce concepts of depreciation and different methods of depreciation.
- To develop estimation skills in estimating cost of manufactured product such as casting,welding, forging, machining.

MODULE I PROCESS PLANNING **9**

Process planning– Aims– Information required– Techniques of process planning – Questionnaire method– Key functional analysis– preparation of processor planning operation sheets– Routing– Process selection– Break even analysis.

MODULE II COST ESTIMATION AND ACCOUNTING **9**

Cost estimation- aims and objectives - cost accounting - aims and accounting - Difference between estimation and accounting - Realistic estimation - Estimation procedure - Elements of cost - Material cost - labour cost-expenses overheads - Factory overheads - Administrative overheads – selling and distribution overheads – components of cost.

MODULE III ESTIMATION OF MATERIAL AND LABOR COST **9**

Material cost estimation – Procedure – Mensuration formulae – Estimation of material cost for different jobs of varying geometries such as casting, forging., Estimation of labour cost –set up time – Tear down time – operation time – Machining time – Time allowances – Relaxation allowances – Personnel allowances – Allowances specific

MODULE IV DEPRECIATION **9**

Depreciation – Definition – causes of depreciation – Methods of depreciation – Straight line Method –Declining balance method – sum of the years digit method – sinking fund method-Annuity method – Repair provision method.

MODULE V ESTIMATION OF COST FOR MANUFACTURING PROCESS **9**

Estimation of cost for forging, welding - Estimation of cost for foundry – Estimation of machining time for various machining operations such as Turning , Drilling, Reaming, Milling, Grinding, Boring, Shaping, Planning operations etc.,

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Design a suitable manufacturing planning sheet for a manufactured product.
CO2 : Arrive at cost of manufactured product in stages.
CO3 : Estimate material and labour cost.
CO4 : Identify a suitable method for depreciation.
CO5 : estimate cost or manufactured product such as casting, welding, forging, machinedcomponent.

REFERENCES:

1. Kesavan R, Elanchezhiyan and C, Vijayaramnath B, Process planning and cost estimation Newage International, Delhi-2009
2. Narang GBS, Production and Costing – Khanna publications – 1991
3. Adithan M, Process planning and cost estimations, New age, 2007.
4. Charles T, Honegran, Srikant M Dater, Madhav V Rajan, Cost Accounting, Pearson, 2015.
5. Pannerselvam R, Sivasankaran P, Process planning and cost estimation, PHI-2016.
6. Peter Scales, Process Planning, Butterworth, 2003.

2403MF005 MICRO SYSTEM TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To Provide Knowledge of Semiconductors and Solid Mechanics of MEMS Devices
- To introduce to various types of fabrication processes in MEMS Devices.
- To educate on the Rudiments of micro devices.
- To provide overview of properties and methods of nanomaterials.
- To educate on the analytical tools for imaging and characterization of MEMS.

MODULE I OVER VIEW OF MEMS AND MICROSYSTEMS 6

Definition – historical development – properties, design and fabrication micro-system, microelectronics, working principle, applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds - silicon piezo-resistors, Gallium arsenide, quartz, polymers for MEMS, conductive polymers.

MODULE II FABRICATION PROCESSES AND MICRO SYSTEM PACKAGING 10

Photolithography, photo resist applications, light sources, ion implantation, diffusion– Oxidation - thermal oxidation, silicon dioxide, chemical vapour deposition, sputtering - deposition by epitaxy – etching – bulk and surface machining – LIGA process – LASER, Electron beam ,Ion beam processes – Mask less lithography. Micro system packaging – packaging design– levels of micro system packaging -die level, device level and system level – interfaces in packaging – packaging technologies- Assembly of Microsystems

MODULE III MICRO DEVICES 8

Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – measurands - displacement sensors, pressure sensor, flow sensors, Accelerometer , chemical and bio sensor - sensitivity, reliability and response of micro-sensor - micro actuators – applications.

MODULE IV SCIENCE AND SYNTHESIS OF NANO MATERIALS 10

Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture Nanoparticles, Sol- Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes – Solid carbon source based production techniques – Gaseous carbon source based production techniques – Diamond like carbon coating. Top down and bottom up processes.

MODULE V INSPECTION OF MICRO/NANO SYSTEMS 11

Micro/Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunnelling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermalproperties – Nano positioning systems.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the properties of various polymers, different materials used for MEMS andworking principle of MEMS.

CO2 : Get knowledge about various fabrication techniques of MEMS.

CO3 : Get awareness of various micro actuators and its application.

CO4 : Impart the knowledge to the students about nano materials and techniques insynthesis of nano materials.

CO5 : Understand the various nano measurements techniques.

REFERENCES:

1. Mahalik N P, MEMS, McGraw Hill (India), 2009
2. Marc Madou , Fundamentals of Micro fabrication, CRC Press, New York, 2011.
3. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006,
4. Sami Franssila, Introduction to Micro fabrication, John Wiley and sons Ltd, 2010.
5. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, NewDelhi, 2007.

6. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, ElsevierInc., 2014.

2403MF006 DESIGN OF MANUFACTURING TOOLS, JIGS AND FIXTURES **L T P C 3 0 0 3**

OBJECTIVES

- To introduce to fundamentals of Jigs and Fixtures and tool materials.
- To understand geometrical features and design of cutting tools.
- To introduce the design steps of tools for metal forming operation.
- To learn the design process of clamping, locator and fixtures.
- To familiarize the design process of Jigs and tool guides

MODULE I INTRODUCTION **9**

Introduction, The design procedure, Drafting and design techniques in tooling drawing. Tooling Materials and Heat Treatment: Introduction, Properties of materials, Ferrous tooling materials, Non-ferrous tooling materials, Non-metallic tooling materials, Heat treatment and tool design. Introduction to Jigs and Fixtures: Definition, Differences between Jigs and Fixtures, principles of Jigs and Fixtures.

MODULE II DESIGN OF CUTTING AND METROLOGY TOOLS **9**

Introduction to metal cutting process and tools, Revision of metal cutting tools-Single point cutting tools, Milling cutters, Drills and Drilling, Reamers, Taps. Selection of carbide tools, determining the insert thickness for carbide tools. Introduction to Design of Tools for Inspection and Gauging, Geometrical Dimensioning and Tolerance, Work piece quality criteria, Principles of gauging, Types of gages and their applications, Amplification and magnification of error, Gage Tolerances, Indicating gages, Automatic gages, Gauging positional tolerance parts, problems.

MODULE III DESIGN OF PRESS TOOLS **9**

Design of Press-working Tools: Power presses, Cutting operations, Types of die-cutting operations - and their design, Evolution of blanking and progressive blanking. Design of Sheet Metal Bending, Forming and Drawing Dies: Introduction, Bending dies, Forming dies, and Drawing dies. Evolution of a draw die, Progressive dies. Strip development for progressive dies, Examples of progressive dies. Extrusion dies, Drop forging dies and auxiliary tools.

MODULE IV DESIGN OF CLAMPS LOCATING METHODS AND FIXTURES **9**

Locating and Clamping Methods: Introduction, Basic principle of location, Locating methods and devices, Basic principle of clamping. Principles of Location: Six degrees of freedom, Duty of the location system, Choice of location system, redundant location, 3-2-1 Location, Types and methods of location. Principles of Clamping: Requirements of the clamping system, Position of theclamps, Design of clamps, Types of clamps: Cam clamp, Toggle clamp. General Principles Of Milling, Lathe, Boring, Broaching And Grinding Fixtures – Assembly, Inspection And Welding Fixtures – Modular Fixturing Systems- Quick Change Fixtures.

MODULE V DESIGN OF JIGS AND TOOL GUIDES **9**

Types Of Jigs –plate Jig, Box Jig, Leaf Jig, Channel Jig ,Post, Turnover, Channel, Latch, Pot, Angular Post Jigs – Indexing Jigs – Design of Drill Jigs: Introduction, Types of drill jigs, General considerations in the design of drill jigs, Drill bushings, Methods of construction. Guiding Elements: Introduction, Guiding the tools, Types of drill bushes.

OUTCOMES

Students at the end of course will be able to

CO1 : Discuss on fundamentals Jigs and Fixtures and tool materials.
CO2 : Brief on geometrical features and design of cutting tools.
CO3 : Understand the design steps of tools for metal forming operation.
CO4 : Carryout design process for clamping, locator and fixtures.
CO5 : To design of Jigs and tool guides

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2. Donaldson, Lecain And Goold "Tool Design", 3rdEdition, Tata McGraw Hill, 2000.
3. Hoffman "Jigs And Fixture Design", Thomson Delmar Learning, Singapore, 2004.
4. Joshi, P.H. "Jigs And Fixtures", 2ndEdition, Tata McGraw Hill Publishing Co., Ltd., New Delhi,2004.
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7. Venkataraman. K., "Design Of Jigs Fixtures and Press Tools", Tata McGraw Hill, New Delhi,2005.

2403MF007 ADVANCED WELDING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To provide overview of different arc and gas welding processes.
- To know various solid state and special welding processes.
- To introduce to metallurgy of welding.
- To design the weldments for various materials.
- To gain knowledge on various welding defects and inspection methods.

MODULE I ARC AND GAS WELDING PROCESSES 9

Fundamental Principles – Air Acetylene Welding, Oxyacetylene Welding, Carbon Arc Welding, Shielded Metal Arc Welding, Submerged Arc Welding, TIG and MIG Welding, Plasma Arc Welding and Electroslag Welding Processes – Advantages, Limitations and Applications - Spot Welding, Seam Welding, Projection Welding, Resistance Butt Welding, Flash Butt Welding, Percussion Welding and High Frequency Resistance Welding Processes – Advantages, Limitations and Applications – RoboticWelding

MODULE II SOLID STATE AND SPECIAL WELDING PROCESSES 9

Cold Welding, Diffusion Bonding, Explosive Welding, Ultrasonic Welding, Friction Welding, Friction Stir Welding - Forge Welding, Roll Welding and Hot Pressure Welding Processes – Advantages, Limitations and Applications - Thermit Welding, Atomic Hydrogen Welding, Electron Beam Welding, Laser Beam Welding, Friction Stir Welding, Under Water Welding, Welding Automation In Aerospace,Nuclear and Surface Transport Vehicles.

MODULE III WELDING METALLURGY 9

Heat flow - temperature distribution-cooling rates - influence of heat input, joint geometry, plate thickness, preheat, significance of thermal severity number, Epitaxial growth - weld metal solidification - columnar structures and growth morphology effect of welding parameters - absorption of gases - gas/metal and slag/metal reactions, Phase transformations- weld CCT diagrams

- carbon equivalent-preheating and post heating weldability of low alloy steels, welding of stainless steels use of Schaffler and Delong diagrams, welding of cast irons - Welding of Cu, Al, Ti and Ni alloys – processes, difficulties, microstructures, defects andremedial measures, Origin - types - process induced defects, - significance - remedial measures**,** Hot cracking - cold cracking -lamellar tearing - reheat cracking - weldability tests - effect ofmetallurgical parameters,.

MODULE IV DESIGN OF WELDMENTS 9

Type of joints, joint efficiency, factor of safety, symbols, selection of edge preparation, design considerations, types of loading, Permissible stress, allowable defects, computation of stresses in welds, weld size calculation, code requirement for statically loaded structures - Design for fluctuating and impact loading - dynamic behaviour of joints – stress, concentrations - fatigue analysis

- fatigue improvement techniques - permissible stress- life prediction, Concept of stress intensity factors - LEFM and EPFM concepts - brittle fracture- transition, temperature approach - fracture toughness testing, application of fracture mechanics to fatigue Welding residual stresses - causes, occurrence, effects and measurements - thermal and mechanical relieving; types of distortion - factorsaffecting distortion - distortion control methods - prediction - correction, jigs, fixtures and positioners.

MODULE V WELDING DEFECTS AND INSPECTION 9

Classification of weld defects- General sources of weld defects- Arc welding defects- Weld defects in other than Arc welding processes. Resistance welding defects- Defects in Friction welding- Defects in friction stir welding - Defects in welds of other welding processes-Visual Inspection-Liquid Penetrant Inspection- Magnetic particle inspection- Ultra sonic testing(UT) Radiography testing (RT) - Eddy current testing –Thermography- Optical and Acoustical holography.

TOTAL : 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the different arc and gas welding processes.
CO2 : Know and perform solid state and special welding process.
CO3 : Understand and analyze the material structures after welding.

CO4 : Design the weldments for various materials.
CO5 : Attain the knowledge about various welding defects and inspection methods.

REFRENCES:

1. Baldev Raj, Practical Non – Destructive Testing, Narosa Publishing House,2009.
2. Lancaster J.F, Metallurgy of Welding, Abington Publishing,6th Edition, 1999.
3. Linnert G. E.,„Welding Metallurgy", Volume I and II, AWS,4thEdition, 1994
4. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM, 2007
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2403MF008 QUALITY AND RELIABILITY ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To study the approaches and techniques to assess quality by statistical process control.
- To study the methodology to assess and sampling of parameters
- To introduce to experimental design and Taguchi method.
- To illustrate the students the concepts of reliability engineering tools.
- To train students the designfor reliability and maintainability.

MODULE I QUALITY AND STATISTICAL PROCESS CONTROL 8

Quality – Definition – Quality Assurance – Variation in process – Factors – process capability – control charts – variables X, R and X, - Attributes P, C and U-Chart tolerance design. Establishing andinterpreting control charts – charts for variables – Quality rating – Short run SPC.

MODULE II ACCEPTANCE SAMPLING 8

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling plans – OCcurves – Producer„s risk and consumer„s risk. AQL, LTPD, AOQL, Concepts – standard sampling plans for AQL and LTPD – use of standard sampling plans.

MODULE III EXPERIMENTAL DESIGN AND TAGUCHI METHOD 9

Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

MODULE IV CONCEPT OF RELIABILITY AND DESIGN 9

Definition – reliability vs quality, reliability function – MTBF, MTTR, availability, bathtub curve – time dependent failure models – distributions – normal, Weibull, lognormal – Reliability of system and models – serial, parallel and combined configuration – Markove analysis, load sharing systems, standby systems, covariant models, static models, dynamic models.

MODULE V DESIGN FOR RELIABILITY AND MAINTAINABILITY 11

Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress-strength and analysis, failureanalysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, system safety – analysis of down-time – the repair time distribution, stochastic point processes system repair time, reliability under preventive maintenance state dependent system with repair. MTTR – mean system down time, repair vs replacement, replacement models, proactive, preventive, predictive maintenance maintainability and availability, optimization techniques for system reliability with redundancy heuristic methods applied to optimal system reliability.

TOTAL: 45 PERIODS

OUTCOMES:

Student will be able to

CO1 : Understand the basic techniques of quality improvement, fundamental knowledge ofstatistics and probability and use control charts.

CO2 : Describe different sampling plans.

CO3 : Solve problems by various design methods.

CO4 : Acquire basic knowledge of reliability.

CO5 : Implement the concepts of reliability and maintainability.

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