NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI - 620 015

M.Tech. DEGREE

in

MANUFACTURING TECHNOLOGY

SYLLABUS

FOR

CREDIT BASED CURRICULUM
OPERATIVE FOR STUDENTS FROM 2015 -2016 ADMISSION
4 SEMESTER PROGRAMME

CODE : PR

DEPARTMENT OF PRODUCTION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY: TIRUCHIRAPPALLI - 620 015
DEPARTMENT OF PRODUCTION ENGINEERING
M. Tech. MANUFACTURING TECHNOLOGY

Department Vision

To establish a world class academy for Manufacturing and Industrial Engineering

Department Mission

- Curriculum development with state-of-the-art technologies
- Pursue research interests of Manufacturing and Industrial engineering
- Consultancy in design, Manufacturing and industrial engineering
- Industry-Institute interaction
- Equipping Laboratories with state-of-the-art equipment

Programme Educational Objectives (PEOs):
PEO 1: Graduates of the programme will be capable of integrating Engineering fundamentals and advanced Manufacturing Engineering concepts.
PEO 2: Graduates of the programme will be professionally competent for gainful employment in Manufacturing functions and sustain future challenges.

Programme Outcomes (POs):

Sl. No	**Attributes**	**Programme Outcomes (POs)** On successful completion of the programme the students will be able to
1	Scholarship of Knowledge	Acquire in depth knowledge in Manufacturing technology with an ability to define, evaluate, analysis and synthesize existing and new knowledge.
2	Critical Thinking	Analyze problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research.
3	Problem Solving	Conceptualize and solve Manufacturing engineering problems and evaluate optimal solutions considering economic and eco-friendly factors
4	Research Skill	Develop scientific/ technological knowledge in Manufacturing engineering through literature survey and design of experiments.
5	Usage of modern tools	Apply of IT tools such as CAD/CAE/CAM for modeling and simulation of complex Manufacturing processes.
6	Collaborative and multi-disciplinary work	Perform collaborate multidisciplinary scientific Manufacturing engineering research through self-management and team work.
7	Project Management and Finance	Demonstrate knowledge and understanding of Manufacturing engineering and management and apply the same to one's own work, as a member and leader in team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

8	Communication	Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9	Life-long Learning	Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10	Ethical Practices and Social Responsibility	Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11	Independent and Reflective Learning	Observe and examine critically the outcomes of one's actions and make corrective measures subsequently and learn from mistakes without depending on external feedback.

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI
DEPARTMENT OF PRODUCTION ENGINEERING
M. Tech. (Manufacturing Technology)
Total minimum credits required: 66
(Operative for students from 2015-2016 admission)

CODE	Semester 1	L	T	P	C	CODE	Semester 2	L	T	P	C
PR 601	Advanced Machining Technology	3	0	0	3	PR 602	Precision Machining	3	0	0	3
PR 603	Flexible Tooling and Automated Inspection	2	1	2	4	PR 604	Theory of Plasticity	2	1	0	3
PR 605	Advanced Welding Processes	3	0	0	3	PR 606	Flexible Manufacturing Systems	3	0	0	3
-----	**Elective I**	3	0	0	3	-----	**Elective IV**	3	0	0	3
-----	**Elective II**	3	0	0	3	-----	**Elective V**	3	0	0	3
-----	**Elective III**	3	0	0	3	-----	**Elective VI**	3	0	0	3
PR607	Advanced Production Process Lab	0	0	3	2	PR 608	Automation & CIM Lab	0	0	3	2
PR609	Advanced Material Processing & Tribology Lab	0	0	3	2	PR 610	Process Modeling, Design & Rapid Manufacturing Lab	0	0	3	2
Total		**17**	**1**	**8**	**23**	**Total**		**17**	**1**	**6**	**22**

CODE	Semester 3	L	T	P	C	CODE	Semester 4	L	T	P	C
PR641	Project Work – Phase I	0	0	24	**9**	PR642	Project Work – Phase II	0	0	24	**12**

LIST OF ELECTIVES

CODE	Materials & Process Stream	L	T	P	C	CODE	Product & System Stream	L	T	P	C
PR 611	Modeling of Manufacturing Processes	3	0	0	3	PR 625	Manufacturing Management	3	0	0	3
PR 612	Advances in Polymer matrix Composites	3	0	0	3	PR 626	Computer Aided Design and Manufacturing	3	0	0	3
PR 613	Heat Treatment	3	0	0	3	PR627	Control of Manufacturing Processes	3	0	0	3
PR 614	Industrial Welding Applications	3	0	0	3	PR 628	Design for Manufacture	3	0	0	3
PR 615	Lasers in Manufacturing	3	0	0	3	PR 629	Industrial Automation and Mechatronics	3	0	0	3
PR 616	Machine Tool Technology	3	0	0	3	PR 630	Product Design and Development	3	0	0	3
PR 617	Manufacturing of Non-metallic Products	3	0	0	3	PR 631	Production Automation and CNC Technology	3	0	0	3
PR 618	Materials Technology	3	0	0	3	PR 632	Rapid Manufacturing	3	0	0	3
PR 619	Mechanical Behaviour of Materials	3	0	0	3	PR 633	Robotics	3	0	0	3
PR 620	Mechanics of Composite Materials	3	0	0	3	PR 634	Terotechnology	3	0	0	3
PR 621	Non-Destructive Testing	3	0	0	3	PR 635	Tolerance Technology	3	0	0	3
PR 622	Smart Materials and MEMS: Design and Fabrication	3	0	0	3		**Common Electives with M.Tech.-Ind. Engg. & Mgmt.**				
PR 623	Surface Engineering	3	0	0	3	PR 654	Modeling and Simulation	2	1	0	3
PR 624	Tribology	3	0	0	3	PR 662	Intelligent Manufacturing Systems	3	0	0	3
						PR 671	Sustainable Manufacturing	3	0	0	3
						PR 672	Project Management	3	0	0	3
						PR 679	Product Life Cycle Management	3	0	0	3

SEMESTER 1

PR 601 ADVANCED MACHINING TECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Select suitable machining process for suitable materials
2. Select optimum parameters for the respective machining process
3. Summarizes the merits and demerits of the non-traditional manufacturing process

Metal Cutting Technology: Introduction to metal cutting - tool nomenclature and cutting forces - thermal aspects of machining - tool materials - tool life and tool wear - traditional and nontraditional machining – high speed machining

Mechanical Processes: Ultrasonic Machining - Water Jet Machining - Abrasive Jet Machining - Abrasive Water Jet Machining - Ice Jet Machining - Magnetic Abrasive Finishing

Chemical and Electrochemical Processes: Chemical Milling - Photochemical Milling - Electropolishing - Electrochemical Machining - Electrochemical Drilling - Shaped Tube Electrolytic Machining

Thermal Processes: Electric Discharge Machining - Laser Beam Machining - Electron Beam Machining - Plasma Beam Machining - Ion Beam Machining

Hybrid Processes: Electrochemical Grinding, Honing, Superfinishing and Buffing – Ultrasonic and Laser Assisted ECM - Electroerosion Dissolution Machining - Abrasive Electrodischarge Machining - EDM with Ultrasonic Assistance

References

1. Bhattacharya "Metal Cutting Theory and Practice", New Central Book Agency (p) Ltd., Calcutta1984.
2. Boothroy .D.G. and Knight. W.A "Fundamentals of Machining and Machine tools", Marcel Dekker, New York, 1989.
3. Hassan Abdel – Gawad El-Hofy "Advanced Machining Processes", McGraw, New York, 2005.
4. Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd Edition, Michigan, 1984.
5. Metals Handbook. Vol. 16, Machining. Materials Park; OH: ASM International, 1995.
6. Kalpakjian, S "Manufacturing Process for Engineering Materials", MA:Addison-Wesley, 1997.
7. Brown, J "Advanced Machining Technology Handbook", New York: McGraw-Hill, 1998.
8. McGeough, J "Advanced Methods of Machining", London. New York: Chapman and Hall, London, 1988.
9. Rumyantsev, E and Davydov, A "Electrochemical Machining of Metals", Moscow:Mir Publishers, 1984.

PR 603 FLEXIBLE TOOLING AND AUTOMATED INSPECTION

L	T	P	C
2	1	2	4

COURSE OUTCOMES:

1. State of Art in Tooling in Manufacturing and Inspection
2. Design and Develop tooling for Flexible Manufacturing
3. Design and Develop Automated Inspection Systems

Introduction to Principles of Tooling in Manufacturing-Economics of Tooling- Pre -Design Product and Process Analysis -Automated Tooling for Machining-Tool Changers-Tool Presets

Flexible Tooling –Tooling for Forming- Evolution of Dies, Forging, Bending and Drawing and Extrusion Processes- Tooling for Casting processes –Mechanization –Flexible tooling in Non Traditional Manufacturing

Tooling for Micro Manufacturing-Tooling for Physical and Mechanical joining Processes-Tooling for CMM-Tool handling Robots.

Principles of Gauging - New concepts for gaging, inspection, checking, machine vision, and robotic testing. Smart Inspection Systems - Techniques and Applications of Intelligent Vision - Stages of automated visual inspection (AVI) and "smart" inspection systems- examples

Application of conventional and artificial intelligence techniques in AVI. AVI process, from illumination, image enhancement, segmentation and feature extraction, through to classification, and includes case studies of implemented AVI systems-Robots in Automated Inspection

Tutorial: Design of Tooling Layout for Automats, Die Design, Modular Fixture Design
Practice: Exercises in CMM and Robots for Inspection

References

1. Mikell P Groover Fundamentals of Modern Manufacturing: Materials, Processes, and Systems John Wiley and Sons 2012
2. Stephen Murphy In-Process Measurement and Control: 32 (Series Manufacturing Engineering and Materials Processing) CRC Press 1990
3. Boothroyd, G. (2005). Assembly automation and product design (Vol. 536). Boca Raton, FL: Taylor & Francis.
4. Stanley L. Robinson, Richard Kendall Miller Automated Inspection and Quality Assurance 1989 CRC Press
5. Duc T. Pham and R J Alcock Smart Inspection Systems: Techniques and Applications of Intelligent Vision Academic Press
6. Black, J. Temple. The Design of the Factory with a Future. McGraw-Hill Companies, 1991

PR 605 ADVANCED WELDING PROCESSES

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Discriminate the knowledge of principles, operations and applications of different casting and welding processes
2. Analyze the effects of process parameters on the quality of cast and weld products
3. Select the NDT techniques for the evaluation of cast and weld components

Welding processes classification, arc welding processes- solid state welding processes, plasma arc welding and ultrasonic welding - Resistance welding process- different types weld joints, welding positions. Brazing, soldering and adhesive bonding, process principles & applications.

Electron beam welding, laser beam welding, Hybrid welding– explosive welding – diffusion bonding – high frequency induction welding –twin wire active TIG welding-A-TIG welding- Hot wire TIG welding- Weld Surfacing & cladding.

Friction Surfacing, Friction stir spot welding, Explosive Welding, Welding of Ni and Ti based alloys, Friction welding with Cu interlayer.

Magnetically impelled arc butt (MIAB) welding - under water welding -Welding of Cu, Al, Ti and Ni alloys – processes, difficulties, microstructures, defects and remedial measures - Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control .

Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects-Inspection & testing of weld joints - Safety aspects in welding.

For Understanding:

Casting basics - design for moulding and casting -advanced moulding and casting processes. Castingdefects – Inspection and testing of casting

References

1. Dr.R.S.Parmer "Welding processes and Technology" Khanna Publishers.
2. H.S.Bawa "Manufacturing Technology-I" Tata Me Graw Hill Publishers New Delhi, 2007.
3. S.V.Nadkami, Modem Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd.
4. CORNU.J. Advanced welding systems – Volumes I, II and III, JAICO Publishers,1994.
5. LANCASTER.J.F. – Metallurgy of welding – George Alien & Unwin Publishers, 1980
6. Carry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2002
7. P .L. Jain “Principles of foundry Technology" Tata Mc Graw Hill Publishers.

PR 607ADVANCED PRODUCTION PROCESS LAB

L	T	P	C
0	0	3	2

1. Micro-turning/ milling/ drilling operation on DT-110 Multi-process micro-machining center.
2. Micro- machining operation on Micro-EDM & Micro-Wire cut EDM.
3. Exercise on Measurement of Specific cutting energy in turning Process.
4. Exercise on Temperature measurement in drilling.
5. Exercise on Stir casting of Aluminum based composites.
6. Manufacturing of PMC using injection moulding .
7. Manufacturing of PMC using compression moulding
8. Joining of Thermoplastic pipes by Resistant welding .
9. Joining of Thermoplastic composite pipes/plates/composite plates by Resistant welding.
10. Joining of Thermoplastic pipes by Fusion Welding Machine.

PR609ADVANCED MATERIAL PROCESSING AND TRIBOLOGY LAB

L	T	P	C
0	0	3	2

1. Exercise on Weld bead performance on GMAW
2. Exercise on Measurement of temperature distribution on GTAW process using thermocouple.
3. Exercise on Water Hammer Forming / Abrasive Machining
4. Laser marking / engraving on metals.
5. Laser micro-welding. / micro drilling / micro channeling
6. Pin-on-disc based tribological characterization of ferrous/ non-ferrous materials at different environment.
7. Measurement of bonding strength of coating using Scratch Tester.
8. Laser transformation hardening of ferrous materials.
9. Laser surface melting of ferrous / non-ferrous materials.
10. Laser surface alloying.

Semester 2

PR 602 PRECISION MACHINING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Recognize the various micro machining techniques
2. Apply various micro/nano finishing techniques for the production of required components
3. State the metrological principles and techniques for the evaluation of precision machined components

Micro- manufacturing- types- micromachining- classification- mechanical advanced micro-machining processes-advanced nano finishing processes-Micro Electro Mechanical Systems (MEMS) - Nano Electro Mechanical Systems (NEMS)

Lithography-diamond turning- micro drilling - micro milling - Electrical Discharge Micro-Machining (EDMM) - Electro Chemical Micro-Machining (ECMM)

Wire Electrical Discharge Micro-Machining (EDMM)- Laser Micro-Machining (LMM) – Types of Lasers

Nano finishing- magnetorheological finishing process-micro/nano finishing with flexible flow of abrasives- Electrolytic In-process Dressing (ELID) Grinding.

Profilometers- optical microscopy- confocal laser scanning microscopy- Scanning Electron Microscope (SEM)-Atomic Force Microscope (AFM).

References

1. M.J. Madou, “Fundamentals of Micro Fabrication”, CRC Press, 2002
2. V.K.Jain, “Introduction to Micromachining”, Narosa Publishing House, 2010
3. Mark J. Jackson, “Micro Fabrication and Nano machining”, Taylor and Francis, 2006
4. Serope Kalpakjian, “Manufacturing Engg. and Technology”, Pearson Education, 2005
5. Yi Qin, “Micro-Manufacturing Engineering and Technology”, Elsevier Publication,2010

PR 604 THEORY OF PLASTICITY

	L	T	P	C
COURSE OUTCOMES	**2**	**1**	**0**	**3**

1. Recognize the various metal forming techniques
2. Apply the theory of plasticity and its application for analyzing various metal forming Processes
3. Describe the advancement in forming technologies

Mohr's Circle, Plastic instability, Tensile test, Advantages of true stress and true strain diagrams etc., Various Yield theories and comparison - Von-Mises Yield theory, Tresca Yield theory, Solving problems related to Yield theories

Plastic instability in biaxial tension, Plastic instability using old Hill's Yield theory, Plastic instability using latest Hill's Yield theory, Plastic instability using Bassni's yield theory

Anisotropy in sheet metals, Hill's Anisotropic Plasticity theory, Special cases, Generalization of Hill's criterion, Bassani's Yield theory, M-K analysis for imperfect sheets, Upper bound theorem, Plane strain, Simple indendation, Compression between smooth plates, Upper bound problems

Slab analysis, Sheet drawing, Wire/rod drawing, Direct compression in plane strain, Sticking friction at interface, Axisymmetric compression, extrusion, Cold rolling theory of strip or plate

Slip line filed theory, Governing stress equations, Properties of SLF, Velocity equations, Derivation of Velocity diagram, Simple stress boundary conditions, Thick walled cylinder under internal pressure solution by SLF method, Processes, Theory of plasticity for porous materials.

References

1. Hosford W.F and Caddell, R.M, "Metal Forming Mechanics and Metallurgy", Prentice Hall, 1983.
2. Narayanasamy R., "Theory of Plasticity", Ahuja Publications, 2000.
3. W.Johnson&P.B.Mellor "Engineering Plasticity" McGraw Hill.

PR 606 FLEXIBLE MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Define the flexibilities in FMS
2. Apply the components of FMS and their integration
3. Analyze the issues related to planning for successful implementation of FMS

FMS Introduction and Description - Objectives and Benefits of FMS - Basic Components of FMS and their integration in the data processing systems - Types of FMS - FMS Layouts – Types of Flexibility - FMS design criteria- Group Technology – Cellular manufacturing - Differences between FMC and FMS

FMS workstations - Machining station – CNC/DNC Features – Machine Tool applications - Machining Centers – Automated Features and Capabilities - Wash Stations - Coordinate Measuring Machines – Contact and noncontact inspection principles - Functions of CMM Computer/software

Material Handling Systems - Introduction to material handling – material transport systems – AGV's - conveyors – storage systems - AS/RS – Automatic data capture - Industrial Robots - Basic Configurations – Sensors in Robotics - robot cell design and control - Applications of Industrial Robots – Robot programming

FMS Software Structure, Functions and Description - General Structure and Requirements - Activities and Functions to be Performed by FMS Software - Requirements of FMS Software - Types of FMS Software Modules - Computer Simulation - Functions of an FMS Host Computer – Distributed systems in FMS – Part program preparation

System Hardware and General Functionality - Programmable Logic Controllers - Cell Controllers - Communication Networks - FMS Installation and Implementation - Case Studies - Just-in-Time production – CIM Technology

References

1. H.K. Shivanand, M.M.Benal, V.Koti, "Flexible Manufacturing System", New Age International Publishers, 2006
2. Mikell P Groover, "Automation Production systems, Computer Integrated Manufacturing", Prentice Hall,1987.
3. Paul Ranky, "The Design and Operation of FMS", IFS publication. 1983.
4. David J Parrish, "Flexible Manufacturing", Butterworth-Heinemann Ltd, 1990

PR 608 AUTOMATION & CIM LAB

L	T	P	C
0	0	3	2

1. Plain turning and facing operations on EMCO turning machine/Step turning on LEADWELL machine.
2. External threading operation on LEADWELL and STC 15 machines.
3. Profile milling operation on VMC machine.
4. Circular pocketing / Rectangular pocketing / drilling operations on EMCO milling machine.
5. Mirroring operation on MTAB milling machine.
6. Simulation of hydraulic circuits in a hydraulic trainer / single and double acting cylinder circuits.
7. Simulation of Electro-pneumatic latch circuits / Logic pneumatic circuits / electro pneumatic sequencing circuits
8. Measurement of form tolerance (circularity, cylindricity and perpendicularity) using CMM
9. Robot programming for pick and place of jobs with vision system / function of ASRS
10. Simulation of CIM environment

PR 610 PROCESS MODELING, DESIGN & RAPID MANUFACTURING LAB

L	T	P	C
0	0	3	2

1. Analysis of stress strain distribution in a plate with center hole using MATLAB coding
2. Transient heat transfer analysis of a rectangular slab using a FEA package
3. Modeling & simulation of hot forging / orthogonal machining / cold rolling operation / milling operation using a FEA package
4. Exercise on Rapid Product Development selection of Rapid Prototyping Technology
5. Exercise on development of prototypes using 3D Printer
6. Life Cycle Assessment using GaBi package
7. Analysis of Geometric Tolerance and manufacturing variation on product designs using Pro/ENGINEER.
8. Assembly tolerance stack up analysis using the RSS Method
9. Tolerance stack up analysis for feature of size, assembly with plus and minus Tolerancing, for floating fastener assembly and fixed fastener assembly.
10. Sustainable Product Development – Developing environmentally friendlier products

LIST OF ELECTIVES

Materials & Process Stream

PR 611 MODELING OF MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Arrange the application of numerical method for non-linear problems
2. Apply numerical methods for manufacturing processes
3. Evaluate the numerical results of manufacturing processes

Review of manufacturing processes, need for numerical solution – Review of basic concepts of numerical methods

FE concepts – variational and weighted residual approaches – Element types – 2D elements – plane triangular, quadrilateral, 3 dimensional axi-symmetric, plate and shell elements – mapping of elements

FE solution for Steady state and transient problems. FE procedure for non-linear problems - Material and geometric non-linearities – solution using implicit and explicit methods

Lagrangean and Eulerian formulations for modelling of machining, rolling, forging, drawing. ALE elements

Thermal modeling for induction hardening, arc welding, cooling of castings – deduction of cooling rate and metallurgical transformations.

References

1. M.Asghar Bhatti "Advanced Topics in Finite Element Analysis of Structures" John Wiley & sons, Inc,2006.
2. Lewis R.W.Morgan, K, Thomas, H.R. and Seetharaman, K.N. The Finite Element Method in Heat Transfer Analysis, John Wiley, 1994.
3. Edward R Champion Jr, "Finite Element Analysis in Manufacturing Engineering", McGraw Hill, 1992.
4. Prakash M. Dixit, Uday S. Dixit"Modeling of Metal Forming and Machining Processes", 1st Edition, 2008, Springer Verlog.
5. Lars-Erik Lindgren, "Computational welding mechanics" , 1st Edition, 2007, CRC Press,

PR 612 ADVANCES IN POLYMER MATRIX COMPOSITES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Describe manufacturing and characterization of polymer matrix composites
2. Perform joining & machining of polymer matrix composites
3. Apply polymer composites for recent industrial applications & confront environmental issues

Polymer matrix –classification- thermoplastics and thermosetting plastics, types of matrix material, reinforcement material- fiber- particulate- whisker, properties of reinforcements and matrix. Composite material-Types-MMC-PMC-CMC, Advantages and Disadvantages.

Manufacturing of PMC material– Lay-up, Autoclave Molding filament Winding, Pultrusion, etc.. Machining of polymeric composite material, Forming methods for Polymers and polymeric composite material- component design consideration.

Joining of PMC-Friction Welding of PMC, Thermal Welding of PMC, Electromagnetic Welding of PMC-Process-Processing Parameters-Materials-Advantages& Disadvantages and Applications. Mechanical fastening of PMC, Chemical bonding of PMC, Joint design, equipment and application methods, Advantages and disadvantages, Applications adhesive bonding

Application of Polymers and PMC material- Automotive Industry- Marine Industry- Materials Handling- Chemical Industry- Electrical & Electronics Industry- Aerospace Industry- Biomedical field.

Recent advancements in polymeric materials-Blends and composites- conducting polymer - nanofibers- Polymeric nanocomposites-Biodegradable Polymeric Nanofibers for Biomedical Applications- nanotube based Conducting Polymer Composite- polymeric nanomaterials in piezoelectric sensors- Biodegradable Polymers to improve new Antifouling coating etc.., Polymer in health care, Environmental issues concerning polymers and polymer in energy application.

References

1. Mein Schwartz., "Composite Materials Handbook", McGraw Hill, 1984
2. "ASM Hand book on Composites", Volume 21, 2001
3. "Handbook of Plastics Joining- A Practical Guide", Plastics Design Library, 13 Eaton Avenue, Norwich, New York 13815.
4. Leonard Hollaway "Handbook of Polymer Composites for Engineers", British Plastics Federation.
5. Edward Arnold, "Process Selection from design to manufacture", 1997.

PR 613 HEAT TREATMENT

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Identify the effect of heat treatment in alloying elements
2. Apply surface modification techniques
3. Find the defects occurring in heat treated parts

Iron - Carbon Equilibrium Diagram: Effect of alloying element on properties of steel and heat treatments. Types and application of heat treatments in manufacturing Industries.

TTT & CCT diagram for steels-Various heating media used for heat treatment, furnaces, Temperature and atmosphere control- Selection of furnace for heat treatment.

Heat Treatment Processes: Annealing – Normalising, Hardenability studies, Jominy end quench test, Grossman's experiments - Tempering, Austempering and Martempering. Thermomechanical treatments.

Surface Modification Techniques: Induction hardening, flame hardening, electron beam hardening and Laser beam hardening. Carburising, nitriding, carbonitriding, CVD and PVD processes, Ion implantation.

Heat Treatment of Non-Ferrous Metals and Specific Alloy steels: Heat treatment of gray irons, white irons (malleabilising) and S.G.irons. Austempering of S.G.Iron. Defects: Defects in heat treated parts, causes and remedy Design for heat treatment.

References

1. Rajan and Sharma "Heat Treatment Principles and Techniques" – Prentice Hall of India (P) Ltd, New Delhi, 2004.
2. Prabhudev, K H., "Handbook of Heat Treatment of Steels", Tata - McGraw Hill Publishing Co., New Delhi, 2000.
3. VijendraSingh,"Heat Treatment of Metals", Standard Publishers Distributors, Delhi, First edition 1998.
4. American Society for Metals, "Metals Handbook Vol.4", ASM Metals Parks, Ohio, USA, 2001.
5. Karl-Erik Thelning, "Steel and its Heat Treatment", Butterworths London, second edition 1984.
6. Novikov I, "Theory of Heat Treatment of Metals", MIR Publishers, Moscow, 1978.

PR 614 INDUSTRIAL WELDING APPLICATIONS

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Apply the knowledge of welding in Heavy Engineering
2. Apply the knowledge of welding in Automotive Industries
3. Apply the knowledge of welding in Nuclear Power

Application of welding in heavy engineering: Boiler manufacture - boiler drum, water wall panels, headers, economizers. Heat exchangers.

Application of welding in oil & gas industries: orbital pipe welding, welding consumables, fabrication codes, inspection &testing, acceptance criteria.

Application of welding in Nuclear Power: Materials, processes, fabrication codes, inspection & testing, reasons for stringent quality control measures.

Application of welding in automotive industries: Thin sheet welding, selection of materials and welding processes, inspection and testing procedure, acceptance criteria.

Application of welding in shipbuilding & Aerospace Industry: Materials involved, welding processes, fabrication code, inspection & testing, acceptance criteria.

References

1. American Welding Society, 'Guide for Steel Hull Welding', 1992
2. Gooch T. S; 'Review of Overlay Welding Procedure for Light Water Nuclear Pressure Vessels', American Welding Society, 1991
3. Winter Mark H, 'Materials and Welding in Off-Shore Constructions', Elsevier, 1986
4. Welding Institute Canada, 'Welding for Challenging Environments', Pergamon Press, 1996.
5. Mishra, R.S and Mohoney, M W, Friction stir welding and processing, ASM 2007.

PR 615 LASERS IN MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Compare the types of lasers and its applications.
2. Employ laser for surface engineering, welding, cutting and drilling.
3. Analyze the micro machining processes by Laser

Fundamentals of laser –lasing action- properties - spectrum and wavelength –wave length chart-types of laser- modes of operation-continuous mode-pulsed mode-laser components - interaction of laser radiation with materials-long pulse and short pulse interaction.

Laser surface treatment –forms of laser surface treatment-laser transformation hardening - advantages - laser surface melting - laser alloying - laser cladding-co-axial powder feeding-lateral powder feeding-laser texturing-case examples-.

Laser welding-process arrangement - mechanisms - applications –modes of welding- conduction limited welding-key hole welding-heat flow theory - one dimensional heat flow - model for stationary and moving point source - simulation of laser welding.

Laser cutting –process characteristics-theoretical models of cutting - practical performance-applications - process variations - drilling –single pulse drilling-percussion drilling- trepanning-applications.

Fiber Laser and UV Laser based marking - micromachining solutions - laser shock loading - basics - applications - laser safety - danger - safety limits - eye and skin - class four safety arrangements - electric hazards - fume hazards.

References

1. William M. Steen, “Laser Material Processing”, Springer Verlag, 2003.
2. M.Young, “Optics and Lasers”, Springer, 1993.
3. K.Thyagarajan, AjoyK.Ghatak, “Lasers, Theory and Applications”, Plenum Press, 1981.
4. J.F. Reddy, “Industrial Applications of Lasers”, Academic Press, New York, 1978.
5. S. S. Charschan, “Lasers in Industry”, Wiley & Sons Inc., 1974.
6. Michael Bass, “Laser Materials Processing”, Elsevier Science, 1983.

PR 616 MACHINE TOOL TECHNOLOGY

	L	T	P	C
COURSE OUTCOMES	**3**	**0**	**0**	**3**

1. Identify various parts of machine tools
2. Apply various design aspects of spindles and bearings
3. Reduce vibration and chatter developing on machine tools

Metal cutting machine tools and their specifications - machine beds and columns - relative merits of different types of beds and columns - design of beds and columns -force on cutting tool.

Types of slideways and design of slideways - wear adjustments in slideways, surface treatment for slideways.

Design of spindles – example for lathe, drilling machine and milling machine, Design of bearing- example for lathe, drilling machine and milling machine, choice of bearings.

Types of drives for machine tool – step and stepless – speed and feed mechanisms – kinematic diagrams. Typical examples for drives in advanced machine tools.

Machine tool vibration – types - effect of undeformed chip thickness variations, rake and clearance angle variations - stability of cutting operation - regenerative chatter - testing of machine tools for alignment and accuracy - standard test charts.

References

1. Sen and Bhattacharya, “Principles of Machine Tools”, New Central Book Agencies, 1975.
2. Boothroyd,G., “Fundamentals of Metal Machining and Machine Tools”, McGraw Hill, 1985.
3. Acherkan,, “Machine Tool Design”, Vol. 2 & 3, MIR Pub, 1973

PR 617 MANUFACTURING OF NON-METALLIC PRODUCTS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Describe the types of polymers and its manufacturing techniques
2. Describe the application, types of glass and ceramics and their manufacturing methods
3. Knowledge in types of composites and their manufacturing techniques

Polymers - classification - Thermoplastics and thermosetting plastics - Thermoforming processes - compression and transfer molding - injection molding - extrusion - blow molding - calendaring - lamination and pultrusion.

Rubber - additives - applications. Stages in raw rubber and latex rubber technology - Processing of rubbers –Manufacturing techniques - tires - belts - hoses - foot wears - cellular products - cables. Manufacture of latex based products

Glass - characteristics - application - glass making - Glass forming machines - hollow wares flat glasses, fiberglass, bulbs, bottles, heat absorbing glasses, amber glass and their manufacturing methods, general plant layouts for manufacture of different types of glasses.

Ceramics - classification - traditional ceramics - structural ceramics - fine ceramics - bio ceramics - ceramic super conductors. Ceramic processing techniques - hot pressing - hot isostatic pressing (HIP) - Sintering - injection molding - slip casting - tape casting - gel casting - extrusion.

Composites - requirements of reinforcement and matrix - Manufacturing of composites - casting - solid state diffusion - cladding - HIP - liquid metal infiltration - liquid phase sintering - preparation of molding compounds and prepregs - hand layup method - autoclave method - filament winding method - compression molding - reaction injection molding - knitting - braiding.

References

1. Ghosh, Polymer Science and Technology – Plastics, Rubber, Blends, and Composites, Tata-Mcgraw hill, 1989.
2. J.L.White, Rubber Processing Technology, Materials and Principles, Hanser Publishers, 1995.
3. E. B. Shand, Glass Engineering Handbook, McGraw-Hill, 2nd Edition, 1958.
4. Kingery, w d &etc Introduction to ceramics 2ndedtion, John Wiley & Sons publ 2004
5. ASM Handbook, Vol. 21 Composites, 2001 Lubin, Handbook of Composites, Springer, 1st Edition, 1982.

PR 618 MATERIALS TECHNOLOGY

	L	T	P	C
COURSE OUTCOMES	**3**	**0**	**0**	**3**

1. Classify the mechanical properties of materials
2. Relate the various forming process
3. Apply the knowledge in formability

Crystal structure, Slip planes, Slip systems and Formability, Close packed planes and directions, Tensile test, Yielding behavior, True stress, strain, Strain hardening, Dislocations, Tensile instability, Constitutive material relationships, Strain rate and sensitivity, Volume constancy principle, Mass constancy principle

Effect of Mohr's circle on Formability, Formability of low carbon steels, Automobile grade steels
Effect of grain size on Formability, Effect of second phase particles on formability

Formability of Carbon - Manganese steels, Micro alloy steels, HSLA steels, I.F steels, Dual phase steels, etc., Formability of Stainless steels

Diffused necking and localized necking in tensile test, Super plasticity and its applications, Deep drawing and deep drawability of sheet metals, Defects in deep drawing

Cold working, Hot working and Warm working, Recrystallization, Forming Limit Diagram, Workability of materials.

References

1. George Krauss, "Steels; Processes, Structure& Performance", ASM International, The Materials Information Society, 2005
2. Narayanasamy R., "Metal Forming Technology", Ahuja publications, New Delhi, 2000.
3. S.Kalpakjian, "Manufacturing Processes for Engineering Materials", Addison Wesley Pub. Co., 1997.

PR 619 MECHANICAL BEHAVIOUR OF MATERIALS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Identify the crystal structure of various materials
2. Analyse the type of fracture in materials
3. Categorize the behavior of creep and fatigue in materials

Introduction, Stress and strain relations, mechanical testing, Elements of plasticity, the flow curve, Strain hardening, Strain rate and temperature dependence of flow stress.

Plastic deformation, slip in crystals, dislocations, and dislocation motion. Twins, strengthening mechanisms, grain boundaries, solid solution strengthening and strain hardening.

Fracture, types of fracture, brittle fracture, Griffith theory of brittle fracture of material, ductile fracture, notch effects, and fracture mechanics.

Fatigue, the S-N curve, low and high cycle fatigue, structural features, surface effects, Creep, stress rupture test, structural changes, creep mechanisms and super plasticity

Embrittlement, residual stresses, mechanical behavior of Ceramics, glasses, polymeric materials, and composite materials.

References

1. Dieter, G. E., "Mechanical Metallurgy", 3rd Ed., McGraw Hill. 1988
2. Courtney, T.H., "Mechanical Behavior of Materials", 2nd Ed., McGraw Hill. 1990
3. Meyers, M.A. and Chawla, K.K., "Mechanical Behavior of Materials", Prentice Hall. 1999
4. R.W.K., "The Plastic Deformation of Metals", Edward Arnold..

PR 620 MECHANICS OF COMPOSITE MATERIALS

	L	T	P	C
COURSE OUTCOMES	**3**	**0**	**0**	**3**

1. Classify the composite materials
2. Categorize the properties of composite materials
3. Apply the knowledge of matrix in composite materials

Classification, Types, characteristics and selection of composites, prepegs, sandwich construction.

Micro and Macro mechanics of a lamina**:** four elastic moduli – Rule of mixture, ultimate strengths of unidirection lamina - Hooke's law - number of elastic constants - Two – dimensional relationship of compliance & stiffness matrix.

Macro Mechanical analysis of laminate - Kirchoff hypothesis – CLT, A,B,& D matrices - Engineering constants - Special cases of laminates, Failure criterion.

Manufacturing processes and Quality assurance of composites.

Metal matrix composites, Application developments - future potential of composites.

References

1. Mein Schwartz, "Composite Materials Hand Book", McGraw Hill, 1984.
2. Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, 1994.
3. Rober M Joness, "Mechanics of Composite Materials", McGraw HIll,1982.

PR 621 NON-DESTRUCTIVE TESTING

	L	T	P	C
COURSE OUTCOMES	**3**	**0**	**0**	**3**

1. Select appropriate non-destructive techniques
2. Apply surface modification techniques
3. Compare the merits of various non-destructive techniques

Visual Inspection **:** Fundamentals of Visual Inspection - metallic materials, raw materials and welds - Inspection objectives, inspection checkpoints, sampling plan, inspection pattern etc. classification of indictions for acceptance criteria - Codes, Standards and Specifications (ASME,ASTM,AWS etc.)-Capabilities, Limitation and Applications

Liquid Penetrant Testing: Principles - types and properties of liquid penetrants - developers - advantages and limitations of various methods - Control and measurement of penetrant process variables - Limitation and Applications

Magnetic Particle Testing: Theory of magnetism - ferromagnetic, Paramagnetic materials - advantages - Circular magnetisation techniques, Limitation and Applications

Ultrasonic Inspection Methods, Equipment/Materials: Principle of pulse echo method, through transmission method, resonance method - Advantages, limitations - Focussing Techniques (SAFT), Time of Flight Diffraction (TOFD), Signal Analysis. Capabilities, Limitation and Applications

Characterization: X-ray Diffraction(XRD) - SEM, Photoluminescence(PL) – Raman Spectroscopy, UV-Vis-IR Spectrophotometer –AFM.

References

1. American Metals Society, "Non-Destructive Examination and Quality Contro!"Metals Hand Book, Vol. I 7, 9th Ed, Metals Park, OH, 1989.
2. Krautkramer, Josef and Hebert Krautkramer, "Ultrasonic Testing of Materials", 3rd Ed, Newyork, Springer-verlag, 1983.
3. A. Goswami, "Thin film fundamentals", New age international (P) Ltd. Publishers, New Delhi, 1996.
4. Birchan, D, "Non Destructive Testing", Oxford University Press, 1977.

PR 622 SMART MATERIALS AND MEMS: DESIGN AND FABRICATION

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Describe the overview of different kinds of smart materials and their applications
2. Describe the various fabrication processes of smart materials and MEMS
3. Deliberate the fundamentals of mechanics for design of smart materials

Introduction to smart materials and MEMS: an overview- scaling issues in MEMS -Micro sensors, some examples –Micro actuators, some examples– Micro systems – Examples of smart systems.

Smart composites - piezoelectric materials, shape memory alloys, magnetic materials -Electro and magneto-statics, Electro active polymers and electrostrictive materials - measurement techniques for MEMS.

Fabrication processes - Structure of silicon and other materials Silicon wafer processing; Thin-film deposition, Lithography, Etching, LIGA, Micromachining, Thick-film processing, Smart material processing.

Mechanics of materials- Stresses and deformation: bars and beams - Micro device suspensions: lumped modeling -Residual stress and stress gradients - Thermal loading; bimorph effect - Vibrations of bars and beams - Gyroscopic effect

Electronics and packing - Semiconductor devices - Signal conditioning for microsystems devices-Vibration control of a beam - Integration of microsystems and microelectronics - Packaging of microsystems.

References

1. Engineering analysis of smart material systems, Donald J. Leo, John Wiley Sons.
2. Smart material systems: model development, R.C. Smith, SIAM.
3. S.D. Senturia, Microsustem Design, Kluwer Academic Publishers, 2001.
4. Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, McGraw Hill, 2002.
5. V.K. Varadan, K.J. Vinoy, and S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, Wiley, 2006.

PR 623 SURFACE ENGINEERING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Compare the use of different surface engineering techniques
2. Select appropriate thermal process to alter the material surface
3. Apply laser for surface modification

Introduction- Significance of surface engineering- Solid surface- Surface energy-Superficial layer- Physico-chemical parameters- Properties of the superficial layer-Surface coating-Classification.

Physical vapor deposition (PVD): Ion plating- Sputter deposition- Reactive deposition-Magnetron sputtering- Chemical vapor deposition (CVD)- Ion implantation- Electron beam technology- Applications.

Thermal Spraying Techniques- Flame Spraying, Atmospheric Plasma Spraying (APS), Vacuum Plasma Spraying (VPS), Detonation-Gun Spraying (D-GUN), High-Velocity Oxy-Fuel (HVOF) Spraying-Applications.

Laser surface engineering- Laser transformation hardening - Laser remelting- Laser alloying-Laser cladding- Laser ablation- Pulsed laser deposition- Laser doping - Laser crystallization-Laser surface texturing- Laser shock peening.

Methods of characterization-Microstructure- Mechanical: Adhesion-Hardness-micro hardness-Residual stress-Friction-Wear- Physical: Porosity-Density- Electrical: Conductivity- Magnetic-Chemical.

References

1.Tadeusz Burakowski, Tadeusz Wierzchon, “Surface Engineering of Metals-Principles, equipment and technologies”, CRC Press, 1999.

2. Lech Pawlowski, "The Science and Engineering of Thermal Spray Coatings", 2nd Edition, John Wiley & Sons, 2008.

3. William M. Steen, Jyotirmoy Mazumder, “Laser Material Processing”, 4th Edition, Springer Verlag, 2010.

PR 624 TRIBOLOGY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Apply the knowledge of tribology in industries
2. Identify the friction and its effect
3. Identify the surface textures

Industrial significance of tribology - Strength and deformation properties of solids - physio-chemical characteristics of solid surfaces –fracture-modes of fracture- ductile-brittle-Analysis of surface roughness - measurement.

Friction - classification - Adhesion theory of friction - Elastic, plastic and visco - elastic effects in friction - rolling friction - friction of materials - alloys - ceramics - polymers - Interface temperature of sliding surfaces - measurement.

Wear - forms of wear-abrasive wear –adhesive wear-erosive wear-cavitation wear-corrosive wear-oxidative wear-fatigue wear-melting wear-diffusive wear-mechanisms-wear of non-metallic materials.

Lubrication –types of lubrication-hydro dynamic lubrication - Reynolds equation - hydrostatic lubrication - bearing analysis – elastohydrodynamic lubrication - solid lubrication - boundary lubrication.

Micro/nano tribology - Measurement techniques - Surface Force Apparatus (SFA) - Scanning Probe Microscopy - Atomic Force Microscopy (AFM)-Nano-mechanical Properties of Solid Surfaces and Thin Films - Computer Simulations of Nanometer-Scale Indentation and Friction.

References

1. I.M. Hutchings, “Tribology: Friction and Wear of Engineering Materials”, Elsevier Limited, 1992.
2. G. W. Stachowiak, A. W. Batchelor, “Engineering Tribology”, Elsevier Limited, 2005.
3. K.C. Ludema, “Friction, wear, lubrication: A text book in tribology”, CRC Press, 1996.
4. Bharat Bhushan, “Principles and applications of tribology”, John Wiley & Sons, 1999.
5. Bharat Bhushan, “Nanotribology and Nanomechanics: An Introduction”, Springer, 2008.

Product & System Stream

PR 625 MANUFACTURING MANAGEMENT

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1.Understand the methods for strategic and operational decision making
2.Define and plan manufacturing problems within the business and sustainability constraints
3.Develop and analyze quantitative models for manufacturing problems

Nature of production- Strategic, Tactical and Operational decisions considering values and ethics- General discrete location-allocation problems - features and formulations. Facility location models - Median model - Distribution model - Brown and Gibson model, Min-max algorithm, Gravity location algorithm.

Aggregate production planning - ways to absorb demand fluctuations - costs relevant to aggregate production planning - aggregate production planning models, heuristics, transportation and linear models – Inventory management –Inventory control policies- EOQ models-models with price breaks

Operations scheduling - Flow shop - n jobs –Johnson's rule, N-Jobs M machine, CDS heuristics, Palmer heuristics- Assembly Line Balancing- Project Scheduling-CPM-PERT-crashing of project network with cost trade off

Material Requirement Planning (MRP) - working of MRP - master production scheduling - Lot sizing in MRP system-rough cut capacity planning -capacity requirement planning, Introduction to ERP and softwares.

Concept of supply management and SCM, Flow in supply chains, Key issues in supply chain management, Decision phases in supply chain, concept of quality management – standards for quality management - Taguchi method of quality control.

References

1. Buffa, Sarin "Modern Production Management", 8th Edition, John Wiley, 1987.
2. Sunil Chopra, Peter Meindl, "Supply Chain Management: Strategy, Planning and Operations", Prentice Hall India, 3rd Edition, 2007
3. Douglas C.Montgomery, "Introduction to Statistical Quality Control", 2nd Edition , John Wiley & sons, 1991

PR 626 COMPUTER AIDED DESIGN AND MANUFACTURING

	L	T	P	C
COURSE OUTCOMES	**3**	**0**	**0**	**3**

1. Define the principles of optimum design
2. Apply surface modelling techniques
3. Analyze production systems at operation level

Basic concepts of CAD - CAD workstation - principles of computer graphics - graphics programming - mechanical drafting package.

Advanced modeling techniques - surface modeling - solid modeling, rendering methods. Graphics and data exchange standards, CAD/CAM data base development and data base management systems.

Principles of optimum design - CAD optimization techniques, design for manufacture and assembly, principles of computer aided engineering, application of CAD, rapid prototyping, concurrent engineering.

Computer aided manufacturing, programming and interface hardware – computer aided process monitoring - adaptive control, on-line search strategies, computer-aided process planning.

Production systems at the operation level - computer generated time standards - machinability data systems - cutting conditions optimization - production planning - capacity planning - shop floor control - computer integrated manufacturing systems, application.

References

1. Radhakrishnan P & Kothandaraman C.P, “Computer Graphics and Design”, Dhanpat Rai& Sons, 1990.
2. Groover M P, “Automation, Production System and Computer Aided Manufacture”, Prentice Hall, 1984.
3. William M Newman & Robert Sproul, “Principle of Interactice Computer Graphics”, McGraw Hill, 1984.
4. Ibrahim Zeid, “CAD/CAM Theory and Practice”, McGraw-Hill, 1991

PR627 CONTROL OF MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Apply and interfere the application of statistical methods in manufacturing processes.
2. Identify the causes of process variation through statistical process control.
3. Apply the experimental design concepts in manufacturing process for problem solving

Review of probability and statistic distributions used in manufacturing processes.
Statistical process control and process capability analysis

Mechanical process variation – analyzing the causes and interpreting data

Alternate SPC methods for manufacturing process control

Application of experimental design in manufacturing

Full factorial models, Response surface modeling and process optimization, Analysis of Process robustness, Case studies

References

1. Montgomery, Douglas C. Introduction to Statistical Quality Control. 5th Ed. New York, NY: Wiley, 2004.
2. Montgomery, Douglas C. Design and Analysis of Experiments. 5th Ed. New York, NY: Wiley, 2004.

PR 628 DESIGN FOR MANUFACTURE

COURSE OUTCOME:

L	T	P	C
3	0	0	3

1. Apply various design rules in manufacturing processes
2. Evaluate the process by design guidelines for optimum design
3. Analyze design alternatives in the manufacture of components

Design process - General Design rules for manufacturability – DFX - basic principles for economical production - creativity in design. Materials: Selection of materials for design developments in material technology - criteria for material selection.

Review of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of simulation in casting design – product design rules for sand casting.

Review of various welding processes, Factors in design of weldments - General design guidelines - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for forming operations.

Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

Redesign for manufacture and case studies: Identification of uneconomical design - Modifying the design. Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology

Reference:

1. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
2. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.
3. Product Design for Manufacturing and Assembly/ Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight/CRC Press/2010.
4. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Co, 1986.
5. Design for Manufacturing-Carrado poli-Elsevier Science and Technology Books-2001.

PR 629 INDUSTRIAL AUTOMATION AND MECHATRONICS

	L	T	P	C
COURSE OUTCOMES	**3**	**0**	**0**	**3**

1. Identify the various types of control valves
2. Apply PLCs in circuits
3. Select appropriate hydraulic and pneumatic circuits

Need for Automation, Hydraulic & Pneumatic system Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics system – Selection criteria. Hydraulic system components selection and specification-characteristics – Linear actuator– construction. Reservoir capacity, heat dissipation, accumulators - standard circuit symbols, circuit (flow) analysis. Direction, flow and pressure control valves-operating-characteristics-electro hydraulic servo valves-types, characteristics and performance.

Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade, method-truth table-Karnaugh map method-sequencing circuits-combinational and logic circuit.

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram.

Programmable logic control of Hydraulics and Pneumatics circuits, Sensors, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

Semi automats-automats-transfer lines - automatic assembly - transfer devices and feeders-classifications and applications-job orienting and picking devices- setting of automats and transfer lines.

References

1. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988
2. Herbert R. Merritt, Hydraulic control systems, John Wiley & Sons, Newyork, 1967
3. Dudbey.A.Peace, Basic Fluid Power, Prentice Hall Inc, 1967
4. Peter Rohner, Fluid Power logic circuit design. The Macmillan Press Ltd.,London, 1979
5. E.C.Fitch and J.B.Suryaatmadyn. Introduction to fluid logic, McGraw Hill, 1978.
6. W.Bolton, Mechatronics, Electronic control systems in Mechanical and ElectricaEngineering Pearson Education, 2003.
7. Peter Rohner, Fluid Power Logic Circuit Design, Mcmelan Prem, 1994.

PR 630 PRODUCT DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Understand the challenges and advancements of product development process
2. Execution of various phases of product development
3. Development of environmentally friendly products/processes

Product development process – various phases, Reverse engineering and redesigning product development process, Illustrations of product development process, S-curve, new product development.

Gathering customer needs, organizing and prioritizing customer needs, establishing product function, FAST method, establishing system functionality. Tear Down and Experimentation- Tear down method, post teardown report, benchmarking and establishing engineering specifications, product portfolios.

Generating Concepts- Information gathering, brain ball, C-sketch/6-3-5 method, morphological analysis, concept selection, technical feasibility, ranking, measurement theory.
Robust design, Design for Manufacture and Assembly, Axiomatic design, TRIZ, Value Engineering, Industrial design, Poka Yoke – Lean principles – Six sigma concepts.

Design for the Environment: DFE methods, life cycle assessment, weighted sum assessment method, techniques to reduce environmental impact – disassembly, recyclability, remanufacturing regulations and standards.

References

1. Kevin Otto and Kristin Wood, ―Product Design – Techniques in Reverse Engineering and New Product Development‖, Pearson Education, 2004.
2. Karl T Ulrich and Steven Eppinger, ―Product Design and Development‖, McGraw Hill, 2011, Fifth Edition.

PR 631 PRODUCTION AUTOMATION AND CNC TECHNOLOGY

L	T	P	C
3	0	0	3

Numerical Control (NC) - input media - design considerations of NC machine tools - functions of MCU- controls and system devices - CNC.

CNC programming- manual part programming – preparatory, miscellaneous functions – computed aided part programming - post processors - APT programming- programming for CNC turning center, machining center and CNC EDM.

Feedback devices– interpolators - tooling for CNC– point-to-point and contouring systems – DNC-Adaptive Control – ACO and ACC systems- graphical numerical control.

Automation – principles – strategies – levels of automation – automated manufacturing systems – devices, drives and control circuits in automation - semi-automats, automats and transfer lines.

Part families-classification and coding-cellular manufacturing- production flow analysis-automated material handling systems- automated storage systems-automatic data capture-automated assembly systems-industrial robots – configurations- applications.

References

1. YoramKoren, "Computer Control of Manufacturing Systems", McGraw Hill Book Co. New Delhi, 1986.
2. Mikell P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2009.
3. Radhakrishnan P., "Computer Numerical Control Machines", New Book Agency, Calcutta, 1991
4. Kundra T. K., Rao P. N., and Tiwari N. K., "CNC and Computer Aided Manufacturing", Tata McGraw Hill, New Delhi, 1991.
5. Fitzpatric.M., “Machining and CNC Technology”, McGraw Hill, 2004

PR 632 RAPID MANUFACTURING

	L	T	P	C
COURSE OUTCOMES	**3**	**0**	**0**	**3**

1. Understand the importance of time compression technologies
2. Selection of appropriate technology for the application
3. Exposure to RP software packages

Introduction- Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, Classification of RP systems.

Principle, process parameters, process details and applications of various RP processes - Stereo lithography systems, Laser Sintering, Fused Deposition Modeling, Laminated Object

Manufacturing, Solid Ground Curing, Laser Engineered Net Shaping, 3D Printing, Laser Melting, Cladding.

Rapid Tooling: Indirect rapid tooling Direct rapid tooling , soft tooling Vs hard tooling, Rapid Manufacturing Process Optimization- Factors influencing accuracy, data preparation errors, part building errors, errors in finishing, influence of part build orientation.

Software for RP: STL files, overview of solid view, magics, mimics, magics communicator, etc., internet based softwares, collaboration tools.

RP Technology selection, Decision Making, Life Cycle Assessment of RP processes, Sustainability issues.

References

1. Pham D T and Dimov S S, "Rapid Manufacturing", Verlag, 2001.
2. Paul F Jacobs, "Stereo lithography and other RP&M Technologies", SME, 1996.
3. Terry Wohlers, "Wohlers Report 2001", Wohlers Associates, 2008.
4. Prasad H and Badrinarayanan, K S, “Rapid Prototyping and Tooling”, SPI-Pageturners, Bangalore, India, 2013.

PR633 ROBOTICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Identify the components of a robot
2. Program robots for different applications
3. Introduce robots in various in various manufacturing techniques

Fundamentals of robotics – wrists design - end effectors – actuators - modular robots.

Robot and its peripherals - sensors, machine vision - image processing & analysis - application of artificial intelligence, voice communication - robot control units - motion controls.

Robot kinematics - homogeneous transformations - forward & inverse kinematics - problems of dynamics - differential relationships - motion trajectories - dynamics of a robot control of single & multiple link robot - static force analysis.

Robot Programming - different languages - expert systems.

Robot applications in manufacturing - material transfer & machine loading/unloading - processing operations – inspection - automation - robot cell design – control – recent developments and special applications-Micro & Bio robotics.

References

1. Richard D Klafter, Thomas A Chmielewski & Michael Negin, "Robotic Engineering – An Integrated Approach", Prentice Hall, 1994.
2. Deb, S.R., "Robotic Technology and Flexible Automation", Tata McGraw Hill, 1994.
3. Fu & Gonzales, "Industrial Robotics", Tata McGraw Hill, 1988.

PR 634 TEROTECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Increase the reliability of a system
2. Conduct reliability analysis
3. Identify appropriate models for reliability measurement

Basic Concepts of reliability –Reliability and Quality –Failures and Failure modes – Causes of failures and unreliability- Maintainability and Availability- Mathematical Expressions - Laplace Transform application in reliability.

Reliability analysis – Mathematical models – Designing for higher reliability– Reliability and Cost - Failure Data Analysis –MTTF in integral form- Numerical analysis.

Component reliability and Hazard Models – Nonlinear hazard model

Redundancy Techniques in System Design- Vibration analysis.

System reliability – Types, Fault Tree Analysis.

References

1. Srinath.L.S, "Reliability Engineering", Affiliated East West Press Pvt. Ltd., 1991.
2. Collacott,R.A. "Mechanical Fault Diagnosis & condition monitoring", Chapman and Hall London, 1977.
3. Balagurusamy.E, "Reliability Engineering", Tata McGraw- Hill Publishing Company Limited, New Delhi, 1984.
4. Birolini.A, "Reliability Engineering: Theory and Practice", Springer-Verlag Publishers, Germany, 2004, Fourth Edition.

PR 635 TOLERANCE TECHNOLOGY

(Use of approved design data book is permitted in the examination)

L	T	P	C
3	0	0	3

COURSE OUTCOMES

1. Identify the general dimensioning techniques
2. Apply the principles of tolerencing in Manufacturing
3. Calculate the optimum material requirement

Introduction to Geometric Dimensioning and Tolerancing, Scope, Definitions, and General Dimensioning, General Tolerancing and Related Principles, Symbology, Datum Referencing, Tolerances of Location, Form, Profile, Orientation, and Runout

Properties of the surface , Principles for tolerancing and geometrical tolerancing- Symbols-Definitions of geometrical tolerances-Tolerance zone-Form of the tolerance zone- Location and orientation of the tolerance zone-Width of the tolerance zone-Length of the tolerance zone-Common tolerance zone- Datums- Axes and median faces- Screw threads, gears and splines - Angularity tolerances and angular dimension tolerances-Twist tolerance.

Profile tolerancing, Tolerancing of cones, Positional tolerancing, projected tolerance zone, Substitute elements, Maximum material requirement, Envelope requirement, least material requirement

Tolerancing of flexible parts, Tolerance chains (accumulation of tolerances), Statistical tolerancing, respecting geometrical tolerances during manufacturing- Manufacturing influences-Recommendations for manufacturing,

General geometrical tolerances, Tolerancing principles, Inspection of geometrical deviations, Function-, manufacturing-, and inspection-related geometrical tolerancing, Examples of geometrical tolerancing, Tolerancing of edges, ISO Geometrical Product Specifications (GPS).

References

1. Gene R. Cogorno “Geometric Dimensioning and Tolerancing for Mechanical Design”, McGraw-Hill,2006
2. Georg Henzold “Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection-A Handbook for Geometrical Product Specification using ISO and ASME Standards”, Elsevier, Second edition
3. Bryan R. Fischer “Mechanical Tolerance Stackup and Analysis” Advanced Dimensional Management, Sherwood, Oregon, U.S.A., Marcel Dekker,Inc.
4. ASME “Dimensioning and Tolerancing”, Y14.5M-1994 [REVISION OF ANSI Y14.5M-1982 (RI98811)]

COMMON ELECTIVES WITH M.Tech. (IE&M)

PR654 MODELING AND SIMULATION

L	T	P	C
2	1	0	3

COURSE OUTCOMES:

1.Develop Manufacturing Models of Discrete event systems
2.Generation of Uncertainty using Random numbers and Random Variates
3. Perform Input, Output Analysis: Verification & Valediction of Models and Optimization

Introduction to systems and modeling - discrete and continuous system - Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System

Random number generation Properties of Random Numbers –Generation of Pseudo Random Numbers –Techniques –Tests for Random Numbers

Random variates-Inverse Transform Technique –Direct Transform Techniques Convolution Method Acceptance Rejection Technique– Routines for Random Variate Generation

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

Simulation languages and packages-Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK-Simulation based optimization-Modeling and Simulation with Petrinets-case studies in manufacturing systems

References

1. Jerry Banks & John S.Carson, Barry L Nelson, "Discrete event system simulation" ,Prentice Hall
2. Law A.M, "Simulation Modelling and Analysis", Tata Mc Graw Hill
3. NarsinghDeo, " System Simulation with Digital Computer", Prentice Hall
4. Pidd, M, "Computer Simulation in Management Science", John Wiley & Sons, Inc.

PR662 INTELLIGENT MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Apply various knowledge based techniques
2. Practice diagnosis and trouble shooting
3. Adopt intelligent system

Basic concepts of Artificial intelligence and expert systems - System Components - System architecture and Data flow – System Operations.

Knowledge based systems - knowledge representation – knowledge acquisition and optimization - Knowledge based approaches to design mechanical parts and mechansims and design for automated assembly.

Knowledge based system for material selection – Intelligent process planning system. Intelligent system for equipment selection - Intelligent system for project management & factory monitoring.

Scheduling in manufacturing – scheduling the shop floor – Diagnosis & trouble shooting.

The role of Artificial Intelligence in the factory of the future – Intelligent systems.

References

1. Kenneth R.Baker, "Introduction to sequencing and scheduling", John Wiley & Sons, New York, 2000.
2. Richard W. Conway, William L.Maxwell and Louis W. Miller,"Theory of Scheduling", Dover Publications, 2003.
3. Andrew Kussiak, "Intelligent Manufacturing Systems", Prentice Hall, 1990.
4. Simons, G.L, "Introducing Artificial Intelligence", NCC Pub, 1990.
5. Rich,E., "Artificial Intelligence", McGraw Hill, 1986.

PR 671 SUSTAINABLE MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Explain the importance of sustainable development
2. Exhibit competence on the usage and applicability of sustainability tools
3. Compute sustainability performance through the indicators

Concepts of sustainability and sustainable development – Need for sustainable development - Components of sustainability- Social, Economic, Environmental dimensions - Linkages between technology and sustainability - Sustainable Manufacturing –Scope, Need and Benefits.

Tools and Techniques of Sustainable Manufacturing – Environmental Conscious Quality Function Deployment, Life cycle assessment, Design for Environment, R3 and R6 cycles, Design for Disassembly -Sustainable Product Development – Various Phases.

EIA Methods –CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters - Interactions between energy and technology and their implications for environment and sustainable development.

Design for recycling – Eco friendly product design methods – Methods to infuse sustainability in early product design phases – Multi-Criteria Decision Making in Sustainability.

Frameworks for measuring sustainability- Indicators of sustainability – Environmental, Economic, Societal and Business indicators - Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.

LAB EXERCISES

Life Cycle Assessment of products using GaBi package

Sustainable Product Development – Developing environmentally friendlier products

References

1. G. Atkinson, S. Dietz, E. Neumayer, — "Handbook of Sustainable Manufacturing". Edward Elgar Publishing Limited, 2007.

2. D. Rodick, "Industrial Development for the 21st Century: Sustainable Development Perspectives", UN New York, 2007.

3. Rogers, P.P., Jalal, K.F. and Boyd, J.A., "An Introduction to Sustainable Development", Earthscan, London, 2007.

4. P. Lawn, "Sustainable Development Indicators in Ecological Economics", Edward Elgar Publishing Limited.

5. S. Asefa, "The Economics of Sustainable Development", W.E. Upjohn Institute for Employment Research, 2005.

PR672 PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Explain the methods for project identification & appraisal
2. Define and plan a project within the constraints of the environment
3. Develop & analyze quantitative models for project selection & scheduling

Introduction - Project Management: An Overview – Types, Characteristics of Projects – Project life cycle. Identification of investment opportunities - Screening and Selection, Project Appraisal,

Market and demand analysis- market survey-demand forecasting methods-Technical analysis – manufacturing process, materials-product mix, plant location-project charts and layouts.

Financial analysis – cash flows for project appraisal- Investment evaluation using capital budgeting techniques - net present value, profitability index internal rate of return, payback period, accounting rate of return

Mathematical Techniques for project evaluation – Linear programming, goal programming, Network technique for Project Management – CPM, PERT, Multiple projects and constraints, scheduling.

Organization systems for project implementation- Work Breakdown-coordination and control-Project Management Softwares

References

1. Prasanna Chandra, "Projects – Planning, Analysis, Financing, Implementation and Review", Tata McGraw Hill,4th Ed, 1997
2. S.Choudry "Project Management", Tata McGraw Hill,27th Ed, 2006
3. John M Nicholas, "Project Management for Business and Technology", 2nd edition, Pearson Education Asia, 2001

PR679 PRODUCT LIFE CYCLE MANAGEMENT

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

1. Recognize the importance of Product Life Cycle Management
2. Realize potential for Collaborative Product Development and digital manufacturing in contemporary manufacturing applications
3. Competence to develop PLM strategy and conduct PLM assessment

Introduction to Product Life Cycle Management(PLM)- Definition, PLM Lifecycle model, Need for PLM, Opportunities and benefits of PLM, Components and Phases of PLM, PLM feasibility study

PLM Concepts, Processes and Workflow - Characteristics of PLM, Environment driving PLM,PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM.

Collaborative Product Development- Engineering vaulting, product reuse, smart parts, engineering change management, Bill of materials and process consistency, Digital mock-up and prototype development, design for environment, virtual testing and validation, marketing collateral

Digital Manufacturing – PLM Digital manufacturing, benefits manufacturing, manufacturing the first-one, Ramp up, virtual learning curve, manufacturing the rest, production planning

Developing a PLM strategy and conducting a PLM assessment- Strategy, Impact of strategy, implementing a PLM strategy, PLM initiatives to support corporate objectives. Infrastructure assessment, assessment of current systems and applications

References

1. Antti Saaksvuori, Anselmi Immonen, " Product Lifecycle Management", Springer, 2005
2. John Stark, "Product lifecycle management: 21st century paradigm for product realization", Springer 2006 London, 3rd printing -2006. 441 pp., ISBN: 1-85233-810-5.
3. Michael Grieves, "Product lifecycle management: Driving the next generation of Lean thinking", McGraw-Hill, 2006
4. Kari Ulrich and Steven D. Eppinger, "Product Design & Development", McGraw Hill International Edition, 1999