`NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI - 620 015

M.Tech. DEGREE

(MANUFACTURING TECHNOLOGY)

4 SEMESTER PROGRAMME

CODE : PR

SYLLABUS

FOR

CREDIT BASED CURRICULUM

OPERATIVE FOR STUDENTS OF 2011 -2012 ADMISSION

DEPARTMENT OF PRODUCTION ENGINEERING

JUNE 2011

M. Tech. MANUFACTURING TECHNOLOGY

CURRICULUM 2011-2012 FOR FULL TIME STUDENTS (4 Semesters)

Curriculum Structure:
The total minimum credits required for completing the programme is 60

Semester I

CODE	COURSE OF STUDY	L	T	P	C
MA 609	Computational Methods in Engineering	2	1	0	3
PR 601	Tooling for Manufacturing	2	1	0	3
PR 603	Casting and welding Technology	2	0	2	3
PR 605	Manufacturing Management	3	0	0	3
---------	Elective I	3	0	0	3
---------	Elective II	3	0	0	3
		16	2	2	18

Semester II

CODE	COURSE OF STUDY	L	T	P	C
PR 602	Advances in Manufacturing Technology	2	0	2	3
PR 604	Mechanics of Metal Forming	2	1	0	3
PR 606	Computer Integrated Manufacturing	3	0	0	3
PR 608	Advanced Finite Element Analysis	3	0	0	3
---------	Elective III	3	0	0	3
---------	Elective-IV	3	0	0	3
		16	1	2	18

Semester III

CODE	COURSE OF STUDY	L	T	P	C
PR 647	Project Work - Phase-I	0	0	12	12
					12

Semester IV

CODE	COURSE OF STUDY	L	T	P	C
PR 648	Project Work - Phase-II	0	0	24	12
					12

List of Electives:

CODE	COURSE OF STUDY	L	T	P	C
PR 611	Tolerance Technology	3	0	0	3
PR 612	Robotics	3	0	0	3
PR 613	Intelligent Manufacturing Systems	3	0	0	3
PR 614	Machine Tool Technology	3	0	0	3
PR 615	Total Quality Engineering	3	0	0	3
PR 616	Product Analysis and Cost Optimization	3	0	0	3
PR 617	Computer Aided Design and Manufacturing	3	0	0	3
PR 618	Modeling and Simulation	3	0	0	3
PR 619	Industrial Welding Applications	3	0	0	3
PR 620	Manufacturing of Non-metallic Products	3	0	0	3
PR 621	Materials Technology	3	0	0	3
PR 622	Fracture Mechanics and Mechanisms	3	0	0	3
PR 623	Press Tools in Metal Forming	3	0	0	3
PR 624	Mechanics of Composite Materials	3	0	0	3
PR 625	Theory of Plasticity	3	0	0	3
PR 626	Advanced Materials Processing	3	0	0	3
PR 627	Tribology	3	0	0	3
PR 628	Mechanical Behaviour of Materials	3	0	0	3
PR 629	Product life cycle Management	3	0	0	3
PR 630	Rapid Manufacturing and tooling techniques	2	0	2	3
PR 631	Boundary Element Methods	3	0	0	3
PR 632	Robust Design	3	0	0	3
PR 633	Modeling and Optimization of Manufacturing Processes	3	0	0	3
PR 634	Metal Cutting Technology	3	0	0	3
PR 635	Project Management	3	0	0	3
PR 636	Terotechnology	3	0	0	3

MA 609 COMPUTATIONAL METHODS IN ENGINEERING

Algebraic equations: Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods (Gauss- Siedel), convergence of iteration methods, Eigen values and Eigen vectors.

Interpolation methods: Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials, Differentiation and Integration: High accuracy differentiation formulae, extrapolation, derivatives of unequally spaced data, Gauss quadrature and integration

Differential equations: Initial and boundary value problems, Eigen value problems, solutions to elliptical and parabolic equations, partial differential equations

Statistical methods: Statistical representation of data, modeling and analysis of data, tests of hypotheses, Introduction to regression analysis

Introduction to optimization methods: Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function, Introduction to heuristic techniques.

REFERENCES

1. Schilling R.J and Harris S L, "Applied Numerical Methods for Engineering using MatLab and C", Brooks/Cole Publishing Co., 2000.

2. Chapra S C and Canale R P, "Numerical Methods for Engineers", McGraw Hill, 1989.

3. Hines, W.W and Montogomery, "Probability and Statistics in Engineering and Management Studies", John Willey, 1990.

4. Santhosh K.Gupta, "Numerical Methods for Engineers", New age international publishers, 2005.

5. Deb Kalyanmoy, " Optimization for Engineering Design: Algorithms and Examples" Prentice-Hall of India Pvt.Ltd, 10th edition, 2009

PR 601 TOOLING FOR MANUFACTURING

Introduction to manufacturing processes – objectives, organization and role of tool engineering – role of materials in tooling.

Tooling for material removal process like traditional machining processes, nontraditional machining processes automats and NC and CNC machines.

Tooling for forming processes.

Tooling for casting and metal joining processes – molding and pattern design mechanization of foundries Design of welding fixtures – tooling for mechanical joining processes.

Tooling for inspection and gauging – design and manufacturing of gauges – CMM – CAD in tool design.

REFERENCES

1) Hoffman E.G, "Fundamentals of tool design", SME, 1984.
2) Kalpakjian S., "Manufacturing Engineering and Technology", Addision Wesley, 1995.
3) HMT "Production Technology", Tata McGraw Hll, 1991.

PR 603 CASTING AND WELDING TECHNOLOGY

Core making processes - design for moulding and casting - different moulding and casting processes-function of the gating system-permanent mould casting-centrifugal casting-investment casting-mercast casting-continuous casting-low pressure casting.

Melting and quality control of various steels and non-ferrous alloys - casting defects - fettling, inspection and testing of castings - Manufacturing of Cast irons – Inspection and testing of casting.

Arc welding power sources-Different arc welding processes-solid state welding process-soldering, Brazing and adhesive bonding – metal surfacing and spraying-thermal cutting processes.

Welding metallurgy – welding of advanced materials-welding of plastics-High frequency welding – Different types of joint configuration-different types of welding position-design of weldments and joints.

Inspection and testing of welding– Defects, Destructive tests - Non destructive testing techniques – surface treatments-safety aspects in welding processes- special welding process (friction stir welding and hybrid (laser +GMAW/GTAW) process.

TEXT BOOKS

1. P.L.Jain " Principles of foundry Technology" Tata Mc Graw Hill Publishers.
2. Dr.R.S.Parmer "Welding processes and Technology" Khanna Publishers.

REFERENCES

1. H.S.Bawa "Manufacturing Technology-I" Tata Mc Graw Hill Publishers New Delhi, 2007.

2. S.V.Nadkarni, Modern Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd.

PR 605 MANUFACTURING MANAGEMENT

STRATEGY PLANNING

Nature of production- Strategic, Tactical and Operational decisions. General discrete location-allocation problems - features and formulations. Facility location models - median model - distribution model - brown and gibson model

TACTICAL PLANNING

Aggregate production planning - ways to absorb demand fluctuations - costs relevant to aggregate production planning - aggregate production planning models – Inventory management –inventory control policies- EOQ models-models with price breaks

SCHEDULING

Operations scheduling - Flow shop - n jobs – 2 machine Johnson's rule, 2 Jobs –M machine, N-Jobs M machine Sequencing Job on parallel machine - Assembly Line Balancing- Project Scheduling-CPM-PERT-crashing of project network with cost trade off

MRP & MRP-II

Material Requirement Planning (MRP) - working of MRP - Use of MRP system - evolutionfrom MRP to MRP II - master production scheduling - rough cut capacity planning -capacity requirement planning - Lot sizing in MRP II system.

SCM & QUALITY MANAGEMENT

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 - statistical process control - Taguchi method of quality control.

REFERENCES

1. H.G. Menon,, "TQM in New Product Manufacturing", Mc Graw Hill, 1992.
2. Hax and Candea., "Production and Inventory Management", Prentice Hall, 1984.
3. Buffa., "Modern Production Management", John Welley, 1983.
4. Douglus C.Montgomery, Introduction to statistical quality control, 2nd Edition , Jhon Wiley & sons, 1991
5. Sunil Chopra, Peter Meindl, Supply Chain Management: Strategy, Planning and Operations-, Prentice Hall India, 3rd ed. (2007)

PR 602 ADVANCES IN MANUFACTURING TECHNOLOGY

Precision engineering – concepts and significance – micro fabrication – types - top down – bottom up approaches –Micro Electro-Mechanical Systems (MEMS) - LIGA process – lithography steps – X ray lithography – masks – mask materials.

Micromachining – theory of micromachining – types – concepts – tools used in micromachining – micro EDM – micro wire cut EDM – micro ECM – micro EDG - abrasive jet micromachining - water jet micromachining.

Laser based micromachining – types of Lasers – diode, excimer and Ti: Sapphire lasers – nanosecond pulse micro fabrications – shielding gas.

Nano-engineering –concepts – significance and applications – nano surface generation – diamond turning – ELID grinding – electron beam nano fabrication.

Nano metrology – surface texture measurement – surface integrity measurement – talysurf profilometer – scanning electron microscope – atomic force microscope – scanning tunneling microscope - commercialization issues of micro-nano technology.

TEXT BOOK

1. *M. J. Madou, "Fundamentals of Micro Fabrication", CRC Press, 2nd edition, 2002*

REFERENCES

1. *Serope Kalpakjain, "Manufacturing Engineering and Technology", Pearson Education, 4th edition, 2005.*

2. *Mark J, Jackson, "Micro fabrication and Nanomachining", Taylor and Franci Group, 2006.*

PR 604 MECHANICS OF METAL FORMING

Basics of metal forming - Mohr's circle - isotropic elasticity - yield theories - plastic stress-strain relationship - plastic work - the principle of normality - incremental plastic strain.

Constitutive relationships - mechanical properties - work hardening - compression test, bulge test, plane strain compression test - plastic instability in tension tests.

Strain rate - super plasticity - slab analysis for sheet drawing - Extrusion and forging - upper bound solution for Extrusion - Indentation and plane strain forging.

Slip line field theory and its solution - Formability and its testing.

Sheet Metal forming - Bending theory, Cold Rolling theory - Hill's anisotropic plasticity theory - Hill's general yield theory, CAD/CAM applications in Extrusion, Forging and sheet metal Forming - Localized necking in biaxial stretching.

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) Scrope Kalpakjian,, "Manufacturing processes for Engineering Materials", Addision Wesley, 1997.

PR 606 COMPUTER INTEGRATED MANUFACTURING

Introduction to CIM, General purpose software subsystems and software tools used in CIM - Computer networks - DBMS.

The Business data processing system of CIM: Scheduling, Computer aided design: Graphic standards – Three dimensional and solid modeling.

Computer aided manufacture: system architecture, CNC machines: Measuring systems, Sensors and their integration with the control architecture– Programming of CNC machines.

Flexible manufacturing systems: System architecture, Material handling systems: Conveyors, AGV's, Robots and storage systems (AS/RS) – auxiliary devices, Examples of FMS installations.

Manufacturing support systems: Inspection Technologies – Automatic data capture – PLC's - process planning and Concurrent Engineering - Interfacing of computers with other systems.

REFERENCES

1. *Paul G Ranky, Computer Integrated Manufacturing, Prentice Hall International, 1996.*
2. *Mikell P Groover, Automation Production systems and Computer Integrated Manufacturing, Pearson Education, 2007.*
3. *P. Radhakrishnan, CAD/CAM/CIM, New age International publishers, 2004.*
4. *Rembold, Computer Integrated Manufacturing Technology and Systems, Marcel Dekker, 1985.*
5. *Vajpayee (S.Kant), Principles of Computer Integrated Manufacturing, Prentice Hall, 1995.*

PR 608 ADVANCED FINITE ELEMENT ANALYSES

Review of the equations of Mechanics - Concepts of stress and stress - strain relationship. Tensors - Transformation law, Tensor Algebra and Integral theorems. Energy Theorems - Principle of Stationary Potential Energy and Virtual work Principle - Constrained Variational Principles.

Finite element formulation from a functional and Virtual work - Iso-parametric formulation - Interpolation, Quadrature rule, patch test - Element and Mesh Instabilities

Displacement based elements - plane, solid and structural elements - Introduction to nonlinear finite element – Newton- Raphson Procedure, contact analysis

Element formulation for transient and steady state heat transfer problems

Finite elements for large deformation – solution of linear finite – element systems and nonlinear finite element systems- Application of FEA to Machining and Forming processes

REFERENCES

1. *S.S.Rao, "The Finite Element Method in Engineering", Third Edition, Butterworth-Heinemann Publishers, 1998.*
2. *Chandrupatla, Belegundu, "Introduction to Finite Elements in Engineering", 2nd Edition, Prentice Hall College Div, 1990*
3. *Edward R Champion Jr,, "Finite Element Analysis in Manufacturing Engineering", Mc Graw Hill, 1992.*
4. *G.W. Rowe, C.E.N. Sturgess, P.Hartley, I. Pillinger "Finite Element Plasticity and Metal Forming Analysis", Cambridge publications,1992.*
5. *G. R. Liu S. S. Quek, "The Finite Element Method: A Practical Course", Butterworth-Heinemann, 1st Editio*

PR 611 TOLERANCE TECHNOLOGY

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

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

Properties of the surface , Principles for tolerancing , Principles for 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)]*

PR 612 ROBOTICS

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.

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 Mc Graw Hill, 1994.*
3. *Fu & Gonzales,, "Industrial Robotics", Tata Mc Graw Hill, 1988.*

PR 613 INTELLIGENT MANUFACTURING SYSTEMS

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. *Andrew Kussiak,, "Intelligent Manufacturing Systems", Prentice Hall , 1990.*
2. *Simons, G.L, "Introducing Artificial Intelligence", NCC Pub, 1990.*
3. *Rich,E., "Artificial Intelligence", Mc Graw Hill, 1986.*

PR 614 MACHINE TOOL TECHNOLOGY

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 and design of slideways - wear adjustments.

Design of spindles and bearings – 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.

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", Mc Graw hill, 1985.*
3. *Acherkan,, "Machine Tool Design", Vol 2 & 3, MIR Pub, 1973.*

PR 615 TOTAL QUALITY ENGINEERING

Basics of quality – Quality objectives- Quality control-Quality Assurance- Quality cost – quality gurus and their philosophies.

Control charts for variables and attributes – process capability studies.

Design of experiments – ANOVA- Taguchi methods- Reliability – MTBF – MTTR.

Acceptance sampling by variables and attributes – ASN – ATI – AOQL

Quality function deployment – FMEA – Quality circles - ISO 9000 series and 14000 series –

Kaizen – six sigma concepts.

REFERENCES

1. *Dougles C. Montgomery, Introduction to statistical quality control 6 th edition, John wiley & sons, 2008.*
2. *Philips J.Ross, Taguchi techniques for quality engineering, 2 nd edition, Mc Graw Hill, New York, 1996.*
3. *E.L.Grant and Leavenworth, statistical quality control, Tata Mc graw Hill, 2008.*
4. *Amitava Mitra, Fundamentals of quality control and improvements, Prentice hall, 2005.*

PR 616 PRODUCT ANALYSIS AND COST OPTIMISATION

New product strategy, market definition - idea generation - design process - forecasting sales potential - product engineering, manufacturing planning - selection of economical process - standardisation - implification – specialization - break even analysis.

Value engineering – evaluation of function determining function - classifying function - evaluation of costs - evaluation of worth - determining worth - evaluation of value - value engineering.

Job plan information phase - speculation phase - analysis phase - development phase - presentation phase - implementation phase - follow up phase - fast diagramming - cost models - life cycle costs.

Cost accounting - cost estimation

Cost calculations for machined components, welding, casting and forging components - calculation of selling price - activity based cost analysis.

REFERENCES

1. *Samual Eilon, "Elements of Production Planning and Control",Universal Book Co, 1984*
2. *Miles L.D, "Techniques of Value Engineering and Analysis", McGrawHill, 1972.*
3. *Narang, C.B.S and Kumar V, "Production and Costing", Khanna publishers ,1983.*

PR 617 COMPUTER AIDED DESIGN AND MANUFACTURING

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

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

Principles of optimum design - CAD optimization techniques, Application of CAD - computer-aided process planning - post processing - NC code generation - principles of computer aided engineering and concurrent engineering.

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

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, system components, 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", Mc Graw Hill, 1984.*

PR 618 MODELING AND SIMULATION

Introduction to systems and modeling - discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation. Discrete event simulation and their applications in queuing and inventory problems.

Random number generation an their techniques - tests for random numbers.

Random variate generation.

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

Simlation languages and packages - FORTRAN, C , C++, GPSS, SIMAN V, MODSIM III,ARENA,QUEST,VMAP - Introduction to GPSS – Case studies - Simulation of manufacturing and material handling system.

REFERENCES

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

PR 619 INDUSTRIAL WELDING APPLICATIONS

Heat exchanges, power cycle piping, super heaters, reheaters, economizer, auxiliary pipes, materials, processes and testing/inspection

Processes and Materials selection for industry, fabrication techniques and field welding for pressure vessel applications, Economics of welding

Materials, processes, fabrication and construction, use of automatic welding and systems in automobile industry, automation

Oil and gas industry, materials, processes, fabrication, inspection and testing, case studies, recent trends and developments

Materials, processes, fabrication, inspection and testing, reasons for stringent quality control measures in nuclear industry

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 620 MANUFACTURING OF NON-METALLIC PRODUCTS

Polymers - classification - based on source - structure - applications. Thermoplastics and thermosetting plastics - properties - compounding of polymer resins - forming processes - compression and transfer molding - injection molding - extrusion - blow molding - calendaring - lamination and pultrusion.

Rubber - types - properties - additives - applications. Stages in raw rubber and latex rubber technology - mastication - mixing - compounding and vulcanization. Processing of rubbers – extrusion - calendaring - injection molding. Manufacturing techniques - tyres - belts - hoses - foot wears - cellular products - cables. Manufacture of latex based products - dipped goods - foams - threads.

Glass - physical characteristics - application - glass making - storage and handling.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. Structure of ceramic crystals: Atomic structure - Interatomic bonds - crystal structures. Preparation techniques of Al_2O_3, ZrO_2, SiC, Si_3N_4, BN and B_4C. Ceramic processing techniques - hot pressing - hot isostatic pressing (HIP). Sintering - Sinter / HIP - injection molding - slip casting - tape casting - gel casting - extrusion.

Composites - classification - advantages - application - functional requirements of reinforcement and matrix - properties and applications of whiskers - particle reinforcements. Manufacturing of metal matrix composites - casting - solid state diffusion - cladding - hot isostatic pressing. Manufacturing of ceramic matrix composites - liquid metal infiltration - liquid phase sintering. Manufacturing of polymer matrix composites - preparation of molding compounds and prepregs - hand layup method - autoclave method - filament winding method - compression molding - reaction injection molding. Manufacturing of carbon - carbon composites - knitting - braiding.

REFERENCES:

1. *J. A. Brydson, Newnes-Butterwarths, Plastic materials, London, 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. *M.W. Barsoum, Fundamentals of Ceramics, McGraw-Hill Co., Inc., 1997.*
5. *George Lubin, Handbook of Composites, Springer, 1st Edition, 1982.*

PR 621 MATERIALS TECHNOLOGY

Classification of materials – mechanical properties of metals.

Plastic instability – strain hardening / work hardening – strengthening mechanisms – cold working and recrystallization.

Plastic working of metals – formability of sheet metals – Forming Limit Diagram (FLD) –super plastic forming.

Workability of bulk metals – workability diagrams – necking and fracture of metals.

Machinability of carbon steels and nonferrous metals – machinability index.

REFERENCES

1. Geller Y.A and Rakhshtadr "Science of Materials", MIR Pub, 198.6
2. Narayanasamy R., "Theory of Plasticity", Ahuja publications, 2000.
3. S.Kalpakjian, "Manufacturing Processes for Engineering Materials", Addision Wesley Pub Co, 1997.

PR 622 FRACTURE MECHANICS AND MECHANISMS

Introduction sources of micro and macro cracks fracture criterion based on stress concentration and theoretical strength Griffith's energy - various approach - Stress Analysis for Members with Cracks.

Crack tip Plastic Zone: Plastic zone estimation - yielding fracture mechanics.

Elastic–Plastic Fracture Mechanics - Path-independent integrals, J-integral , J-integral fracture criterion, crack opening displacement(COD), experimental determination of J-integral and COD - Fatigue and Fatigue crack growth rate.

Linear static fracture Mechanics Design Concepts - Introduction, the stress criterion, strain energy density, 2-D linear elastic crack problems.

Dynamic Fracture: Mohr's model, strain energy release rates, crack branching, practical applications of crack arresting techniques. Experimental determination of dynamic SIF. -NDT and Fracture Mechanics

REFERENCES

1. *S.A. Maguid,, "Engineering Fracture Mechanics", Elsevier, 1996*
2. *David Broke., "Elementary Engineering Fracture Mechanics", Noordhoff, 1995.*
3. *Karen Hellan, "Introduction to Fracture Mechanics", Mc Graw Hill, 1982.*

PR 623 PRESS TOOLS IN METAL FORMING

Elements, classification of press tools - clearance between punch and die, shut height and daylight, press tonnage calculation - Strip layout, Basic rules, economic layout, bridge size, calculation of plug point/center of pressure.

Types of Press tools, construction of press tools, press tools for hydro forming, tools for super plastic forming.

Types and Role of tooling in the deformation system - Tools for cold extrusion, force analysis, analogue method, nomograms - Tool design - Punch pressure significances - Tolerancing cold extrudes based on VOl data - Design chart for a complete sequence of producing a cold extrude.

Forging Tools - Design of upsetting tools.

Bending and Forming tools, Dies for headers, transfer mechanisms. Design of tool for deep drawing Cutting tools - methods of reducing forces, die pillar set, fine blanking tools.

REFERENCES

1. *Paquin Jr,, "Die Design Fundamentals", New York Industrial Press, 1987.*
2. *Dallas, B. Daniel,, "Progressive Dies", Michigan-SME, 1994.*
3. *Smith A David, "Die Design Hand Book", SME, 1990.*

PR 624 MECHANICS OF 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", Mc Graw Hill, 1984.*
2. *Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, 1994.*
3. *Rober M Joness, "Mechanics of Composite Materials", Mc Graw HIll,1982.*

PR 625 THEORY OF PLASTICITY

Iinvariance in terms of the deviatoric stresses, representative stress - Engineering and natural strains, cubical dilation, finite strains co-efficients, Octahedral strain, strain rate and the strain rate tensor.

Yield criteria for ductile metal - Yield criteria for an anisotropic material. Stress – Strain Relations – Plastic stress-strain relations, Prandtl Roeuss Saint Venant, Levy – Von Mises, Yield locus, symmetry convexity, normality rule.

Application to problems, simple forms of indentation problems using upper bounds. Problems of metal forming.

Crystal Plasticity, the crystalline state, crystallographic indices, the preferential planes and directions, critical shear stress, theory of simultaneous slip, slip bands, the plastic bending in crystals, dislocations and crystal growth, polycrystals and grain boundaries,

Plane plastic strain and the theory of the slip line filed, two dimensional problems of steady and non steady motion, plastic anisotropy.

REFERENCES

1. *Narayanasamy R, "Theory of Engineering Plasticity", Ahuja Publications, 2000.*
2. *Johnson and Mellor, "Plasticity for Mechanical Engineers", Ban Nostrand, 1973.*
3. *R.Hill , "The Mathematic theory of Plasticity", Oxford Publication, 1982.*

PR 626 ADVANCED MATERIALS PROCESSING

Fundamentals of laser - properties - spectrum and wavelength - types of laser - laser components - interaction of laser radiation with materials.

Laser surface treatment - laser transformation hardening - advantages over conventional processes - laser surface melting - laser alloying - laser cladding.

Introduction to laser welding - process arrangement - process mechanisms - operating characteristics - process variations - applications - heat flow theory - one dimensional heat flow - model for stationary and moving point source - simulation of laser welding.

Introduction - methods of cutting - theoretical models of cutting - practical performance - applications - process variations - drilling - applications.

Fiber Laser and UV Laser based marking - micromachining solutions - automotive - electronic - food - jewellery - medical - other industrial sectors - 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, Ajoy K.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 627 TRIBOLOGY

Industrial significance of tribology - Strength and deformation properties of solids - Adhesion and cohesion properties of solids - physio-chemical characteristics of solid surfaces - Analysis of surface roughness - 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 - abrasive wear - mechanisms - wear resistance of materials - erosive wear - cavitation wear - adhesive wear - corrosive and oxidative wear - fatigue wear - fretting wear - wear debris - wear of non-metallic materials.

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) - Nanomechanical 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*.

PR 628 MECHANICAL BEHAVIOUR OF MATERIALS

Introduction, Stress and strain relations, mechanical testing, elastic behavior, and viscoelasticity. 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 cycle fatigue, structural features, surface effects, and metallurgical variables. Creep, the creep curve, 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 629 PRODUCT LIFE CYCLE MANAGEMENT

Product lifecycle management-concepts, benefits, value addition to customer. Lifecycle models-creation of projects and roles, users and project management, system administration. Product development process and functions.

Data transfer. Variants of e-commerce. Multisystem information sharing. Workgroup collaboration. Development of standard classification for components and suppliers. Customization factors-creation of business objects, user interfaces, search facile ties as designed by the enterprise.

Quality function deployment-quality project approach and the problem solving process. Design creativity-innovations in design alternatives. Concurrent engineering, industrial design principles Product development versus design, types of design and redesign, examples of product development process, scoping product development – S-curve, new product development.

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

Information gathering, brain ball, C-sketch/6-3-5 method, morphological analysis, concept selection, technical feasibility, ranking, measurement theory, DFMA, design for robustness. Types of prototypes, use of prototypes, rapid prototyping technique scale, dimensional analysis and similitude, physical model and experimentation.

REFERENCES

1. *John W Gosnay and Christine M Mears, "Business Intelligence with Cold Fusion", Prentice Hall India, New Delhi, 2000.*
2. *Alexis Leon, "Enterprise Resource Planning", Tata McGraw Hill, New Delhi, 2002.David Bedworth, Mark Hederson and Phillip Wolfe, "Computer Integrated Design and Manufacturing" McGraw Hill Inc., New York, 1991.*
3. *Kevin Otto and Kristin Wood, "Product Design – Techniques in Reverse Engineering and New Product Development", Pearson Education, New Delhi, 2004*.

PR 630 RAPID MANUFACTURING AND TOOLING TECHNIQUES

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, Selective Laser Sintering, Fused Deposition Modeling, Laminated Object Manufacturing, Solid Ground Curing, Laser Engineered Net Shaping, 3D Printing.

Rapid Tooling: Indirect rapid tooling - silicone rubber tooling, aluminum filled epoxy tooling, spray metal tooling, Direct rapid tooling - direct AIM, copper polyamide, sand casting tooling, laminate 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.

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

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.*

PR 631 Boundary Element Methods in Manufacturing

Principle of boundary element method; conversion of basic weighted residue statement into boundary integral equation – inverse statement, concept of fundamental solution; application to potential problem in two and three dimensions; type of boundary elements

Introduction to formulation of problems in elastostatics, Problems involving large Problems Involving Large Stains and Rotations

Solution for thermal linked manufacturing problems – Design sensitivities and optimization

Planar Forming Processes - Axisymmetric Forming Processes - Solidification Processes

Solution to Machining Processes - Integral Equations for Ceramic Grinding Processes

REFERENCES

1. *Abhijit Chandra and Subrata Mukherjee, "Boundary Element Methods in Manufacturing", Oxford Engineering Science Series, 47, 1997*
2. *D. J. Cartwright, "Underlying Principles of the Boundary Element Method", WIT Press, 2001*
3. *Gernot Beer, "Programming the Boundary Element Method: An Introduction for Engineers", John Wiley, 2001*

PR 632 ROBUST DESIGN

Introduction- Planning of experiments – Steps – Need - Terminology: Factors, levels, variables, experimental error, replication, Randomization, Blocking, Confounding.

Single Factor Experiments- ANOVA rationale - Sum of squares – Completely randomized design, Randomized block design, effect of coding, Comparison of treatment means – Newman Kuel's test, Duncan's Multiple Range test, Latin Square Design, Graeco-Latin Square Design, Balanced incomplete design.

Factorial Experiments-Main and interaction effects –Two and three Factor full factorial Designs, 2^k deigns with Two and Three factors-Unreplicated design- Yate's Algorithm

Special Experimental Designs: Blocking in factorial design, Confounding of 2^k design, nested design-Response Surface Methods.

Taguchi Techniques- Fundamentals of Taguchi methods, Quality Loss function, orthogonal array designs, application to Process and Parameter design, case studies.

REFERENCES

1. *Montgomery, D.C. "Design and Analysis of Experiments", John Wiley and Sons, 5th Edition, 2002.*
2. *Ross, P.J. "Taguchi Techniques for quality Engineering", Tata McGraw Hill, 2000.*
3. *Hicks,C.R. "Fundamental concepts in the Design of Experiments", Holt, Rinehort and Winston, 2000.*
4. *Bagchi, T.P. "Taguchi Methods explained", PHI, 2002.*

PR 633 MODELING AND OPTIMIZATION OF MANUFACTURING PROCESSES

Introduction to modeling to optimization process – Modelling and optimization techniques – Statistical methods – Neural networks – meta- heuristics methods

Modelling and optimization of machining processes - Milling – Drilling – Turning - Grinding and super-finishing process

Modelling and optimization of forming processes – Forging – Extrusion – Rolling – Sheet metal forming

Modelling and optimization of modern machining processes – AWJM- WEDM – ECM – LBM Modeling and optimization of nano-finishing processes – Abrasive flow machining process –

Magnetic abrasive machining process – Electrolytic in process Dressing

REFERENCE

1. R. Venkata Rao, **"**Advanced Modeling and Optimization of Manufacturing Processes, Springer Publishers, 1st edition, 2011

2. Deb Kalyanmoy, "Optimization for Engineering Design: Algorithms and Examples" Prentice-Hall of India Pvt.Ltd, 10th edition, 2009

PR 634 METAL CUTTING TECHNOLOGY

INTRODUCTION

Basic mechanism of chip formation - Types of chips - Chip breaker - Orthogonal Vs Oblique cutting - force and velocity relationship - shear plane angle in orthogonal cutting - Energy Consideration in machining - Modern theories in Mechanics of cutting - Review of Merchant and Lee Shaffer Theories.

Nomenclature of single point tool - Systems of tool Nomenclature and Conversion of rake angles - Nomenclature of multi point tools like drills, milling cutters and broaches. Forces in turning, drilling and milling - specific cutting pressure- measurement of cutting forces.

Thermodynamics of chip formation - Heat distributions in machining - Effects of various parameters on temperature - Method of temperature measurement in machining - Hot machining - cutting fluids.

Essential requirements of tool materials - Developments in tool materials – ISO specifications for inserts and tool holders - Tool life - optimum tool life - Conventional and accelerated tool life tests - Concepts of machinability and machinability index - Economics of machining

Reasons for failure of cutting tools and forms of wear - mechanisms of wear - chatter in machining - Factors effecting chatter in machining - types of chatters - Mechanism of chatter based on Force Vs Speed graph, Mechanism of grinding - Various parameters affecting grinding process

REFERENCES

1. *SHAW .M.C., " Metal cutting Principles ",Oxford clarendon Press,1984.*
2. *BHATTACHARYA. - " Metal Cutting Theory and Practice ", New central Book Agency(p) Ltd.,Calcutta1984.*
3. *VENKATESH .V.C. & CHANDRASEKHARAN.H. - " Experimental Techniques in Metal cutting ", Prentice Hall of India,1982*
4. *JUNEJA.B.L AND SEKHON.G.S- " Fundamentals of metal cutting and machine tools ", New Age International(p) Ltd., 1995*
5. *XING SHENG LI & LOW I.M., Editors Advanced Ceramic TRANSTECH PUBLICATIONS,1994.*
6. *KUPPUSWAMY.G.- " Pinciples of metal cutting ", Universities Press(India)Ltd., 1996*
7. *BOOTHROY.D.G. and KNIGHT. W.A " Fundamentals of Machining and Machine tools "-Marcel Dekker,New York, 1989.*

PR 635 PROJECT MANAGEMENT

Capital investments: Importance and difficulties - Types of capital investments - Phases of capital budgeting - Levels of decision making - Facets of Project Analysis - Feasibility Study - Objectives of capital budgeting - Common weaknesses in capital budgeting - Project Life Cycle.

Technical analysis - Manufacturing process / technology - Materials and inputs - product mix - plant capacity - location and site - machinery and equipment – structures and civil works – project charts and layouts.

Capital allocation frame work - key criteria - Elementary investment options - Portfolio planning models - Strategic position and action evaluation (SPACE) - Financial estimates & Projections - Time value of money - Investment Criteria - Net present value - Benefit cost ratio - Internal rate of return - Payback period - Accounting rate of return.

Risk Analysis of single investments - Multiple projects and Constraints - Project dependence - Capital rationing - Project indivisibility. Mathematical Programming Approach - Linear programming model - Integer programming model - Goal programming model. Network techniques for project management - PERT, CPM.

Introduction to Software Project Management (SPM) - Software Metrics – Software quality – Risk management in SPM- Emerging issues.

REFERENCES

1. *Prasanna Chandra, "Project Management", Tata McGraw Hill, 2002.*
2. *Choudhury, S., "Project management", Tata McGraw Hill, 1988.*
3. *Walker Royce, Software project management, Addison Wesley, Pearson Education.*

PR 636 TEROTECHNOLOGY

Basic Concepts of reliability –Reliability and Quality –Failures and Failure modes – Causes of failures and unreliability- Maintainability and Availability- Mathematical Expressions - Density and Distribution functions for Uniform, Rayleigh, Weibull, Normal distributions- Laplace Transform application in reliability.

Reliability analysis – Mathematical models – Designing for higher reliability– Reliability and Cost - Failure Data Analysis – Failure Density- Failure rate- Reliability – Failure Probability- Mean Failure Rate – Mean Time To Failure – Mean Time Between Failures – MTTF in terms of failure density- MTTF in integral form- Numerical analysis.

Component reliability and Hazard Models – Component reliability from test data – Time dependant hazard models - Field data curves – Constant Hazard model- Linear hazard model – Nonlinear hazard model – Gamma model- Stress dependant hazard models.- Derivation of reliability function using Markov model.

Redundancy Techniques in System Design- Component versus Unit redundancy- Weakest Link Technique- Mixed redundancy- Standby redundancy- Maintenance and Spares Management – Vibration analysis – Vibration monitoring concepts – Vibration signature – Vibration monitoring equipment- Condition based maintenance.

System reliability – Series Configuration, Parallel Configuration, Mixed Configuration, Fault Tree Analysis – Block diagram, Tie Set and Cut Set approaches, Probability and Reliability calculations.

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.*