NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015

M.Tech. DEGREE
in
(MANUFACTURING TECHNOLOGY)

SYLLABUS
FOR
CREDIT BASED CURRICULUM
OPERATIVE FOR STUDENTS OF 2013 - 2014 ADMISSION
4 SEMESTER PROGRAMME
CODE : PR

DEPARTMENT OF PRODUCTION ENGINEERING
JUNE 2013
# National Institute of Technology: Tiruchirappalli - 620 015
## Department of Production Engineering
### M. Tech. MANUFACTURING TECHNOLOGY


**Curriculum Structure:**

The total minimum credits required for completing the programme is 66

<table>
<thead>
<tr>
<th>CODE</th>
<th>Semester – 1</th>
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**List of Electives:**

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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

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
PR 603 CASTING AND WELDING TECHNOLOGY

Core making processes - design for moulding and casting - different moulding and casting processes.

Melting and quality control of various steels and non-ferrous alloys - casting defects - Inspection and testing of casting


Basics of welding metallurgy, thermal cycle, weld and their characteristics. Hot and cold cracking, measures to avoid hot, cold cracking in welds.

Inspection & testing of weld joints - Special welding processes - Friction Stir welding, Laser-hybrid welding. Safety aspects in welding.

REFERENCES

2. Dr.R.S.Parmer "Welding processes and Technology" Khanna Publishers.

PR 605 MANUFACTURING MANAGEMENT

Strategy Planning- Strategic, Tactical and Operational decisions.

Discrete and continuous facility location models location-allocation problems formulations,

Tactical planning- aggregate production planning models, Inventory management, Scheduling Flow shop Assembly Line Balancing Project Scheduling

Material Requirement Planning (MRP),Lot sizing in MRP, MPS, ERP,

SCM, concept of quality management.

REFERENCES

PR 633 CNC AND MICRO-MACHINING LAB

List of Experiments:

1. Exercise on Step turning operation on LEADWELL machine.
2. Exercise on External threading operation on LEADWELL and STC 15 machines.
3. Exercise on Profile milling operation on VMC machine.
4. Exercise on Rectangular pocketing and drilling operations on EMCO milling machine.
5. Exercise on Mirroring operation on MTAB milling machine.
7. Exercise on computer aided part-programming for machining operations.

PR 635 ADVANCED PRODUCTION PROCESSES LAB

List of Experiments:

2. Exercise on Temperature measurement in drilling.
3. Exercise on Electrical Discharge Machining.
4. Exercise on Electrochemical Machining.
5. Exercise on Resistant welding & Fusion Welding of polymeric composites.
6. Exercise on Production of polymer components by Injection moulding.
7. Exercise on Electrical Discharge Alloying and Characterization
8. Exercise on Stir casting of Aluminum based composites.
9. Exercise on Weld bead performance on GMAW
11. Exercise on Water Hammer Forming
12. Exercise on Abrasive Machining
Micromachining-classification-mechanical advanced micromachining 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)
Wire Electrical Discharge Micro-Machining (EDMM)-Electrical Discharge Grinding (EDG)-Electro Chemical Micro-Machining (ECMM) – Laser Micro-Machining (LMM)

REFERENCES

PR 604 MECHANICS OF METAL FORMING

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.

REFERENCES
PR 606 FLEXIBLE MANUFACTURING SYSTEMS

Introduction to FMS - concepts, advantages, components and examples of FMS, Distributed Numerical Control (DNC) - Communication between DNC computer and MCU.
Distributed data processing in FMS - Computer network protocols - Interfacing of CAD and CAM - Part programming in FMS tool data base - Clamping devices and fixtures data base, tool management system part alignment and work mounting errors, surface description method for automated design and robotized assembly.
Material Handling systems - ASRS - AGVs – features of industrial robots - robot cell design and control.
Inspection - CMM - incycle gauging - Sensors for robots.
Interfacing of computer - machine tool controllers and handling systems: communications standards - programmable Logic Controllers(PLC's) – Interfacing - Computer aided Project planning - Inventory control.

REFERENCES
PR 608 MODELING OF MANUFACTURING PROCESSES


REFERENCES

PR 634 MANUFACTURING PROCESS MODELING AND RAPID MANUFACTURING LAB

List of Experiments:

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 operation using a FEA package
4. Modeling & simulation of orthogonal machining using a FEA package
5. Modeling & simulation of cold rolling operation using a FEA package
6. Modeling & simulation of milling operation using a FEA package
7. Exercise on selection of Rapid Prototyping Technology
8. Case analysis on various phases of Rapid Product Development
9. Exercise on development of prototypes using 3D Printer
10. Life Cycle Assessment using GaBi package
List of Experiments:

1. Simulation of hydraulic circuits in a hydraulic trainer.
2. Simulation of single and double acting cylinder circuits using different directional control values
3. Simulation of Electro-pneumatic latch circuits
4. Simulation of Logic pneumatic circuits
5. Simulation of electro pneumatic sequencing circuits
6. Simulation of PLC based electro pneumatic sequencing circuits
7. Measurement of form tolerance (circularity, cylindricity and perpendicularity) using CMM
8. Robot programming for pick and place of jobs with vision system
9. Study and function of ASRS
10. Simulation of CIM environment

PR 611 INDUSTRIAL WELDING APPLICATIONS

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: Materials involved, welding processes, fabrication code, inspection & testing, acceptance criteria.

REFERENCES

PR 612 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.

REFERENCES

PR 613 MANUFACTURING OF NON-METALLIC PRODUCTS

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


REFERENCES
Classification of materials – mechanical properties of metals.
Plastic instability – strain hardening / work hardening – strengthening mechanisms – cold working and recrystallization.

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

Machinability of carbon steels and nonferrous metals – machinability index.

REFERENCES

PR 615 MECHANICAL BEHAVIOUR OF 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 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
PR 616 MECHANICS OF COMPOSITE MATERIALS

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

PR 617 METAL CUTTING TECHNOLOGY

Nomenclature of single point tool - multi point tools. Forces in turning, drilling and milling - measurement of cutting forces.
Thermodynamics of chip formation - Method of temperature measurement in machining - Hot machining - cutting fluids.
Essential requirements of tool materials - Conventional and accelerated tool life tests - Concepts of machinability - Economics of machining.
Reasons for failure of cutting tools and forms of wear - chatter in machining - Finite element analysis of metal cutting process.

REFERENCES
6. KUPPUSWAMY.G.- " Pinciples of metal cutting ", Universities Press(India)Ltd., 1996
PR 618 THEORY OF PLASTICITY

Invariance in terms of the deviatoric stresses, representative stress - Engineering and natural strains, cubical dilation, finite strains co-efficients, tensors.
Yield criteria for ductile metal - Yield criteria for an anisotropic material. – Plastic stress-strain relations.
Application to problems, using upper bounds.
Crystallography.
Plane plastic strain and the theory of the slip line filed, two dimensional problems of steady and non steady motion, plastic anisotropy.

REFERENCES

PR 619 TRIBOLOGY

Industrial significance of tribology - Strength and deformation properties of solids - physiochemical characteristics of solid surfaces - Analysis of surface roughness - measurement.
Wear - abrasive wear - mechanisms – Forms of wear - wear of non-metallic materials.
Lubrication - hydro dynamic lubrication - Reynolds equation - hydrostatic lubrication - bearing analysis - elastohydrodynamic lubrication - solid lubrication - boundary lubrication.

REFERENCES
PR 620 LASERS IN MANUFACTURING

Laser welding - process arrangement - mechanisms - applications - heat flow theory - one dimensional heat flow - model for stationary and moving point source - simulation of laser welding.
Laser cutting - theoretical models of cutting - practical performance - applications - process variations - drilling - applications.

REFERENCES:

PR 621 HEAT TREATMENT

Various heating media used for heat treatment, furnaces, Temperature and atmosphere control.

REFERENCES:
Visual Inspection: Fundamentals of Visual Inspection - metallic materials, raw materials and welds - Inspection objectives, inspection checkpoints, sampling plan, inspection pattern etc. classification of indications 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
PR 623 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. 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

PR 624 CNC TECHNOLOGY AND PRODUCTION AUTOMATION

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.


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-applications-robot programming.

REFERENCES

PR 625 RAPID MANUFACTURING

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


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.


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
PR 626 ROBOTICS

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 robots - 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


PR 627 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, 
$2^k$ designs 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

   2002.
3. Hicks,C.R. “Fundamental concepts in the Design of Experiments”, Holt, Rinehert and 


Component reliability and Hazard Models – Nonlinear hazard model

Redundancy Techniques in System Design - Vibration analysis.

System reliability – Types, Fault Tree Analysis.

REFERENCES


PR 629 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, 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, General geometrical tolerances, Tolerancing principles, Tolerancing of edges, ISO Geometrical Product Specifications (GPS).

REFERENCES

Need for Automation, Hydraulic & Pneumatic Comparison – ISO symbols for fluid power Elements

Hydraulic, pneumatic – Selection criteria. standard circuit symbols, circuit (flow) analysis.

Direction, flow and pressure control valves-electro hydraulic servo valves-Different types-characteristics and performance.


Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits. Electronic drive circuits for various Motors.

REFERENCES
Process capability analysis – Cumulative effect of tolerances – Centrality analysis – Compound assembly – Selective and Interchangeable assembly – Grouped Datum systems
Advances in DFMA- Design for robustness – Axiomatic design – DFA index – Poka Yoke – Lean principles – Six sigma concepts – Computer aided DFA using software.

REFERENCES

COMMON ELECTIVES WITH M.Tech (IE&M)

PR 654 MODELING AND SIMULATION


REFERENCES:


PR 658 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

3. Walker Royce, Software project management, Addison Wesley, Pearson Education.
PR 661 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 mechanisms 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

PR 670 SUSTAINABLE MANUFACTURING


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

REFERENCES

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 facilities 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