GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

Regulations, Curriculum And Syllabi For

M.E. (MANUFACTURING ENGINEERING)

(Full Time / Part Time)

2012
Regulations

Curriculum

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CURRICULUM FOR CANDIDATES ADMITTED
DURING 2012-2013 AND ONWARDS
BRANCH: M.E. (MANUFACTURING ENGINEERING) - FULL TIME

FIRST SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
		THEORY							
1.	12MF01	PROBABILITY AND STATISTICS	25	75	100	3	1	0	4
2.	12MF02	DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT	25	75	100	3	0	0	3
3.	12MF03	AUTOMATED COMPUTER INTEGRATED MANUFACTURING SYSTEMS	25	75	100	3	0	0	3
4.	12MF04	ADVANCED MANUFACTURING PROCESSES	25	75	100	3	0	0	3
5.	E1	ELECTIVE 1	25	75	100	3	0	0	3
6.	E2	ELECTIVE 2	25	75	100	3	0	0	3
		TOTAL			600				19

SECOND SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
		THEORY							
1.	12MF05	ADVANCED MATERIALS TECHNOLOGY	25	75	100	3	0	0	3
2.	12MF06	THEORY OF METAL CUTTING	25	75	100	3	0	0	3
3.	12MF07	ROBOTICS AND ROBOT APPLICATIONS	25	75	100	3	0	0	3
4.	12MF08	MANUFACTURING METROLOGY AND QUALITY CONTROL	25	75	100	3	0	0	3
5.	E3	ELECTIVE 3	25	75	100	3	0	0	3
6.	E4	ELECTIVE 4	25	75	100	3	0	0	3
		PRACTICAL							
7	12MF09	ROBOTICS & AUTOMATION LAB	25	75	100			3	2
		TOTAL			700				20

THIRD SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
		THEORY							
1.	12MF10	SUPPLY CHAIN MANAGEMENT	25	75	100	3	0	0	3
2.	E5	ELECTIVE 5	25	75	100	3	0	0	3
3	E6	ELECTIVE 6	25	75	100	3	0	0	3
4.	12MF11	PROJECT WORK I	50	150	200	0	0	12	6
		TOTAL			500				15

FOURTH SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
1.	12MF12	PROJECT WORK II	100	300	400	0	0	24	12
		TOTAL			400				12

CURRICULUM FOR CANDIDATES ADMITTED
DURING 2012-2013 AND ONWARDS
BRANCH: M.E. (MANUFACTURING ENGINEERING) – PART TIME

FIRST SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
1.	12MF01	PROBABILITY AND STATISTICS	25	75	100	3	1	0	4
2.	12MF02	DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT	25	75	100	3	0	0	3
3	12MF03	AUTOMATED COMPUTER INTEGRATED MANUFACTURING SYSTEMS	25	75	100	3	0	0	3
		TOTAL			300				10

SECOND SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
1.	12MF05	ADVANCED MATERIALS TECHNOLOGY	25	75	100	3	0	0	3
2.	12MF06	THEORY OF METAL CUTTING	25	75	100	3	0	0	3
3	12MF07	ROBOTICS AND ROBOT APPLICATIONS	25	75	100	3	0	0	3
		TOTAL			300				9

THIRD SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
1	12MF04	ADVANCED MANUFACTURING PROCESSES	25	75	100	3	0	0	3
2	E1	ELECTIVE: 1	25	75	100	3	0	0	3
3	E2	ELECTIVE: 2	25	75	100	3	0	0	3
		TOTAL			300				9

FOURTH SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
		THEORY							
1	12MF08	MANUFACTURING METROLOGY AND QUALITY CONTROL	25	75	100	3	0	0	3
2	E3	ELECTIVE: 3	25	75	100	3	0	0	3
3.	E4	ELECTIVE: 4	25	75	100	3	0	0	3
4.	12MF09	ROBOTICS & AUTOMATION LAB	25	75	100			3	2
		TOTAL			400				11

FIFTH SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
		THEORY							
1.	12MF10	SUPPLY CHAIN MANAGEMENT	25	75	100	3	0	0	3
2.	E5	ELECTIVE: 5	25	75	100	3	0	0	3
3.	E6	ELECTIVE: 6	25	75	100	3	0	0	3
4.	12MF11	PROJECT WORK I	50	150	200	0	0	12	6
		TOTAL			500				15

SIXTH SEMESTER

S. No.	Subject Code	Course title	Sessional Marks	Final Exam Marks	Total Marks	L	T	P	C
1.	12MF12	PROJECT WORK II	100	300	400	0	0	24	12
		TOTAL			400				12

LIST OF ELECTIVE SUBJECTS

S. No.	Subject Code	Course title
1.	12MF13	ADVANCED MAINTENANCE MANAGEMENT
2.	12MF14	RAPID PROTOTYPING AND TOOLING
3.	12MF15	DIAGNOSTIC TECHNIQUES
4.	12MF16	ADVANCED FINITE ELEMENT METHODS
5.	12MF17	NON DESTRUCTIVE EVALUATION
6.	12MF18	FLUID POWER CONTROL AND AUTOMATION
7.	12MF19	INDUSTRIAL ERGONOMICS
8.	12MF20	OPTIMIZATION TECHNIQUES IN ENGINEERING
9.	12MF21	ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS
10.	12MF22	RELIABILITY AND QUALITY ENGINEERING
11.	12MF23	ADVANCED TOOL DESIGN
12.	12MF24	COMPOSITE MATERIALS
13.	12MF25	CORROSION AND SURFACE ENGINEERING
14.	12MF26	ADVANCES IN CASTING AND WELDING PROCESSES
15.	12MF27	INDUSTRIAL SAFETY MANAGEMENT
16.	12MF28	MEMS AND NANO TECHNOLOGY
17.	12MF29	TESTING, INSPECTION AND QUALITY CONTROL OF WELDMENTS
18.	12MF30	LEAN MANUFACTURING SYSTEMS AND IMPLEMENTATION
19.	12MF31	VIBRATION CONTROL AND CONDITION MONITORING
20.	12MF32	FINANCIAL MANAGEMENT AND COST ACCOUNTING

12MF01 PROBABILITY AND STATISTICS

(*Common with Environmental Engineering*)

L	**T**	**P**	**C**
3	**1**	**0**	**4**

PROBABILITY THEORY **(9)**

Random Experiments – Sample space –Definition of Probability –Conditional Probability – Addition, Multiplication theorems- Theorem of Total Probability- Baye's theorem – Problems.

RANDOM VARIABLES AND DISTRIBUTIONS **(9)**

Discrete random variable- Probability Function- Continuous random variable-Probability density function- Two dimensional random variable-Distributions: Binomial, Poisson, Normal, Gamma- Chebyshev's inequality and its simple problems.

TEST OF HYPOTHYSIS **(9)**

Large samples: Tests for Means, Variances and Proportions –Small samples: Tests for Means, Variances-Goodness of fit and Independence of Attributes using Chi Square distribution.

DESIGN OF EXPERIMENTS **(9)**

Randomized Block design- Completely Randomized Block design-Latin Square design. (Problems only)

STATISTICAL QUALITY CONTROL **(9)**

Control charts for variables: $\overline{X}$, R Charts – Control chart for defective : P, np Chart - Control chart for defects : C charts. Correlation -Regression – Multiple and Partial Correlation – Partial Regression (Problems Only)

Lecture: 45   Tutorial: 15 Total: 60

References:

*1. S.C. Gupta and V. K. Kapoor, "**Fundamentals of Mathematical Statistics**", Sultan Chand & Sons, New Delhi 2007.*

*2. S. P. Gupta, "**Statistical Methods**", Sultan Chand & Sons, New Delhi – 2007.*

*3. Miller and Freud "**Probability and Statistics for Engineers**" , Prentice Hall of India Ltd., New Delhi, Seventh Edition,2007.*

*4. T. Veerarajan, "**Probability , Statistics and Random Process**" , Tata Mc Graw Hill Publishing Company Ltd., New Delhi – 2003.*

*5. P. Kandasamy, K.Thilagavathy and K.Gunavathy, "**Probability and Random Process**", S.Chand & Co. Ltd., New Delhi – 2003.*

*6. Richard A.Johnson and Dean W.Wichem**, "Applied Multivariate Statistical Analysis",** Pearson Education, Asia, Fifth Edition, 2002.*

12MF02 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT

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INTRODUCTION (9)

General design principles for manufacturability –Factors influencing design-Systematic working plan for the designer-Types of problems to be solved-Possible solutions-Evaluation method- Process capability - Feature tolerances -Geometric tolerances - Assembly limits -Datum features - Tolerance stacks-Interchangeable part manufacture and selective assembly.

FACTORS INFLUENCING FORM DESIGN (9)

Materials choice - Influence of basic design, mechanical loading, material, production method, size and weight on form design- form design of welded members and forgings.

COMPONENT DESIGN – CASTING CONSIDERATION (9)

Form design of grey iron, steel, malleable iron and aluminium castings.

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores.

COMPONENT DESIGN - MACHINING CONSIDERATION (9)

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. Identification of uneconomical design - Modifying the design - group technology -Computer Applications for DFMA.

DESIGN FOR ENVIRONMENT (9)

Introduction – Importance of DFE -Environmental objectives – Global issues – Regional and local issues– Design guidelines for DFE –Lifecycle assessment – EPS system - ATANDT's environmentally responsible product assessment - Weighted sum assessment method –Techniques to reduce environmental impact – Design to minimize material usage –Design for disassembly – Design for recyclability – Design for remanufacture –Design for energy efficiency – Design to regulations and standards.

TOTAL: 45

References:

1. *Boothroyd, G, "Design for Assembly Automation and Product Design", New York, Marcel Dekker, 1980.*

2. *Bralla, "Design for Manufacture Handbook", McGraw hill, 1999.*

3. *Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Marcel Dekker, 1994.*

4. *Dickson, John. R, and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, 1995.*

5. *Fixel, J. "Design for the Environment", McGraw hill. 1996.*

6. *Graedel T. Allen By. B, "**Design for the Environment**", Angle Wood Cliff, Prentice Hall. Reason Pub.1996.*

7. *Kevien Otto and Kristin Wood, "**Product Design**", Pearson Publication, 2004.*

8. *Dr.ING.Robert Matouslk, "**Engineering Design**".Blackie & son limited, 1962.*

9. *Harry peck, "**Designing for Manufacture**",Pitman publishing.*

12MF03 AUTOMATED COMPUTER INTEGRATED MANUFACTURING SYSTEMS

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PRODUCTION PLANNING AND CONTROL (9)

Introduction to CIM - Nature of the CIM system - Types of manufacturing systems – Evolution of CIM - Computers in CIM. Process definition and manufacturing planning - Structures of a process plan - CAD based process planning - coding systems - Methods of CAPP – Process planning systems. Background - Role of MRP - II in CIM systems - Major modules of MRP – II software - Manufacturing, Engineering, financial, marketing and misc. applications.

CNC SYSTEMS (9)

CNC Machine tools - Principle of Numerical Control - Types of CNC machine tools – Features and programming of CNC machine tools - CNC programming based on CAD - Applications and economics of usage of CNC machine - Capabilities of a typical NC - CAM software – Integration of computers in CIM environment

NETWORKING (9)

Computer communications - Principles of networking, Techniques, components of networking and wiring methods - Network interface cards - Network standards, examples - Operating system - Security - Managing remote systems - design activity in a networked environment – networking in an manufacturing company

FLEXIBLE MANUFACTURING SYSTEMS (9)

Flexible manufacturing - Introduction, types, major elements and optimization of FMS - Operational elements in a typical FMC - Typical FMS layout - Lean manufacturing – Agile manufacturing database and DBMS requirements - Features and architecture of a DBMS – query language - SQL - SQL as a knowledge base query language. Integration and Implementation issues in CAD/CAM/CIM.

ROBOTICS AND ARTIFICIAL INTELLIGENCE (9)

Artificial Intelligence - Robots -Elements, types and specifications of robots, robot programming methods, robot operation, applications of industrial robots, integration of robots in CIM systems -Expert system - AI in vision system and scheduling - DSS in CIM environment.

TOTAL: 45

References:

1. *Mikell P Groover, "**Automation, Production Systems, & Computer Integrated Manufacturing**", Pearson education (Singapore) Pvt. Ltd., New Delhi, 2003.*

2. *Chris McMahon, and Jimmie Browne, "**CAD/CAM Principles, Practice and Manufacturing Management**", Addison Wesley Longman Limited, England, 1998.*

3. *Narahari Y, Viswanadham N., "**Performance Modeling and Analysis of Automated Manufacturing Systems**", Prentice hall of India, New Delhi, 1998.*

4. *Mikell P Groover, Mitchell Weis, Roger N Nagel, Nicholas G Odrey, "**Industrial   Robotics Technology, Programming and Applications**", McGraw Hill, 1986.*

12MF04 ADVANCED MANUFACTURING PROCESSES

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NEWER MACHINING PROCESSES – I (9)

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

NEWER MACHINING PROCESS – II (9)

Wire cut EDM - Electro chemical machining – ECG - Electric discharge machining – construction – principle – types – control - circuits – tool design – merits, demerits and applications.

NEWER MACHINING PROCESS – III (9)

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

FABRICATION OF MICRO DEVICES (9)

Semiconductors – films and film depurification – Oxidation - diffusion – ion implantation –   etching – metallization – bonding – surface and bulk machining – LIGA Process – Solid free form fabrication.

MICROFABRICATION TECHNOLOGY (9)

Wafer preparation – monolithic processing – moulding – PCB board hybrid and MCM technology – programmable devices and ASIC – electronic material and processing– steriolithography SAW devices, Surface Mount Technology.

TOTAL: 45

References:

1. *Serope Kalpekijian, Stevan R.S.Chmid* **"Manufacturing Process Engg Material",** *2003*

2. *Julian W.Hardner* **"Micro sensors Mems & Smart Devices",** *2002*

3. *Brahem T. Smith "Advanced Machining",* *I.F.S. UK 1989.*

4. *Jaeger R.C.,* **"Introduction to Microelectronic fabrication",** *Addison Wesley, 1988.*

5. *Nario Taniguchi,* **"Nano Technology",** *Oxford University Press 1996.*

6. *Pandey P.C. and Shan HS,* **"Modern Machining Processes",** *Standard Publishing Co., 1980*

7. *More Madon,* **"Fundamentals of Microfabrication",** *CRC Press, 1997.*

12MF05 ADVANCED MATERIALS TECHNOLOGY

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ELASTIC AND PLASTIC BEHAVIOR (9)

Elasticity in metals and polymers An elastic and visco-elastic behavior – Mechanism of plastic deformation and non metallic shear strength of perfect and real crystals –Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behavior – Super plasticity – Deformation of non crystalline materials.

FRACTURE BEHAVIOUR (9)

Griffith's theory, stress intensity factor and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep –Larson Miller parameter – Deformation and fracture mechanism maps – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law. Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

SELECTION OF MATERIALS (9)

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability Corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

MODERN METALLIC MATERIALS (9)

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Tialuminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

NON - METALLIC MATERIALS (9)

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TiC TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

TOTAL: 45

References:

1. *George E.Dieter, "**Mechanical Metallurgy**", McGraw Hill, 1988*

2. *Thomas H. Courtney, "**Mechanical Behavior of Materials**", (2nd edition), McGraw Hill,2000*

3. *Charles, J.A., Crane, F.A.A. and Fumess, J.A.G, "**Selection and Use of Engineering Materials**", (3rd edition), Butterworth-Heiremann, 2001.*

4. *Flinn, R.A., and Trojan, P.K., "**Engineering Materials and their Applications**", (4thEdition) Jaico, 1999.*

5. *ASM Hand book, Vol.11, "**Failure Analysis and Prevention**", (10th Edition), ASM, 2002.*

6. *Ashby M.F., "**Material Selection in Mechanical Design**", 3rd Edition, Butter Worth 2005*

12MF06 THEORY OF METAL CUTTING
[Use of approved data book is permitted]

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ORTHOGONAL CUTTING (10)

Introduction - Machining fundamentals – Metal Cutting - Chip formation - types of chips - Chip breakers - Expression for Shear plane angle - Cutting force and velocity relationship - Ernst and Merchant Upper bound solution - Lee and Shaffer Lower bound solution - Oxley's thin shear zone model - Stress and Strain in the chip - Energy consideration in machining.

OBLIQUE CUTTING (8)

Direction of Chip flow - Normal, Velocity and Effective Rake angles - Relationship between rake angles - Cutting ratios in oblique cutting - Shear angle and Velocity relationship - Stabler's rule.

THERMAL ASPECTS AND CUTTING FLUIDS (7)

Heat distributions in machining - Experimental determination and Analytical calculation of cutting tool temperature - Cutting fluids - Effects of cutting fluid - Functions - Requirements - Types and Selection of Cutting Fluids.

CUTTING TOOL MATERIALS, TOOL LIFE AND TOOL WEAR (10)

Essential requirements of tool materials – development of tool materials - Tool wear and Tool life - Machinability - Economics of metal machining - Theory of Chatter – ISO specifications for inserts and tool holders.

DESIGN OF CUTTING TOOLS (10)

Nomenclature of Single point and Multi point cutting tools - Design of Turning tool, Drills and Milling cutters.

TOTAL: 45

References:

1. Bhattacharyya A., **"Metal Cutting Theory and Practice"**, *Central Book Publishers, Calcutta, 1984.*

2. Juneja B L., Sekhon G. S., **"Fundamentals of Metal Cutting and Machine Tools"**, *New Age International (P) Limited, 1995.*

3. Shaw M C., **"Metal Cutting Principles"**, *Oxford Press, 1984.*

4. Armarego E.J.A., Brown R.H., **"The Machining of Metals"**, *Prentice Hall Inc., 1969.*

5. Geoffrey Boothroyd, Knight W.A., **"Fundamentals of Machining and Machine Tools"**, *Marcel Dekkor, New York, 1989.*

6. Rodin P., **"Design and Production of Cutting Tools"**, *MIR Publishers, 1968.*

7. **"Design Data Book "**, *PSG College of Technology, Coimbatore.*

12MF07 ROBOTICS AND ROBOT APPLICATIONS

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INTRODUCTION AND ROBOTIC KINEMATICS (9)

Definition need and scope of industrial robots-Robot anatomy-work volume-Precision movement-End effectors - sensors. Robot kinematics- Direct and inverse kinematics- Robot trajectories- Control of robot manipulators- Robot dynamics-Methods for orientation and location of objects.

ROBOT DRIVES AND CONTROL (9)

Controlling the robot motion-Position and velocity sensing devices-Design of drive systems-Hydraulic and Pneumatic drives-Linear and rotary actuators and control valves-Electro hydraulic servo valves, electric drives- Motors-designing of end effectors-Vacuum, magnetic and air operated grippers.

ROBOT SENSORS (9)

Transducers and sensors-Sensors in robot-Tactile sensor-Proximity and range sensors-Sensing joint forces- Robotic vision system-Image Gripping-Image processing and analysis-Image segmentation-Pattern recognition- Training of vision system

ROBOT CELL DESIGN AND APPLICATION (9)

Robot work cell design and control-Safety in Robotics-Robot cell layouts-Multiple robots and machine Interference - Robot cycle time analysis - application of robotics in machine shop, assembly, automation, tele operated robot, MHS, Processing operation.

ROBOT PROGRAMMING AND ARTIFICIAL INTELLIGENCE (9)

Methods of robot programming-characteristics of task level languages lead through programming methods-Motion interpolation. Artificial intelligence- Basics- Goals of artificial intelligence- AI techniques.

TOTAL: 45

References:

1. *Mikell P Groover, Mitchell Weis, Roger N Nagel, Nicholas G Odrey, "**Industrial Robotics Technology,Programming and Applications**", McGraw Hill, 1986*

2. *Richard D Klafter, Thomas A Chmielewski, Machine Negin, "**Robotics Engineering - An Integrated Approach**", Prentice Hall of India Pvt., Ltd., 1984*

3. *K.S.Fu, R.C.Gomaler, C.S.G.Lee, "**Robotics control, Sensing, Vision and Intelligence**", McGraw Hill, 1987.*

4. *Lorenzo Scarvicco "**Modelling and control of Robot Manipulator** ", Tata McGraw Hill, 1999.*

5. *James G Kerames, "**Robot technology fundamentals** ", Delmia Publisher-2000.*

12MF08 MANUFACTURING METROLOGY AND QUALITY CONTROL

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LASER METROLOGY (8)

Introduction – types of lasers – laser in engineering metrology – metrological laser methods for applications in machine systems – Interferometer applications – speckle interferometry – laser interferometers in manufacturing and machine tool alignment testing – calibration systems for industrial robots laser Doppler technique – laser Doppler anemometry.

PRECISION INSTRUMENTS BASED ON LASER (9)

Laser telemetric systems – detection of microscopic imperfections on high quality surface Pitter NPL gauge interferometer – classification of optical scanning systems –high inertia laser scan technique – rotating mirror technique – laser gauging – bar coding– laser dimensional measurement system.

CO-ORDINATE MEASURING MACHINE (10)

Co-ordinate metrology – CMM configurations – hardware components – software –Probe sensors – displacement devices – Performance Evaluations – Software –Hardware – Dynamic errors – Thermal effects diagram – temperature variations environment control – applications.

OPTO ELECTRONICS AND VISION SYSTEM (9)

Opto electronic devices – CCD – On-line and in-process monitoring in production –applications image analysis and computer vision – Image analysis techniques – spatical feature – Image extraction – segmentation – digital image processing – Vision system for measurement – Comparison laser scanning with vision system.

QUALITY IN MANUFACTURING ENGINEERING (9)

Importance of manufacturing planning for quality – concepts of controllability – need for quality management system and models – quality engineering tools and techniques –statistical process control – six sigma concepts – Poka Yoke – Computer controlled systems used in inspection.

TOTAL: 45

References:

1. *John A. Bosch, Giddings and Lewis Dayton,* **"Co-ordinate Measuring Machines and Systems"***, Marcel Dekker, Inc, 1999.*

2. *Zuech, Nello "***Understanding and Applying Machine Vision***", Marcel Dekker, Inc, 2000*

3. *Logothetis, N. "***Managing for total quality from Deming to Taguchi and SPC***", PHI, 1997.*

4. *Dale H.Besterfield,* **"Quality Improvement"***, PHI, 2010.*

12MF09 ROBOTICS AND AUTOMATION LAB

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LIST OF EXPERIMENTS

1.   Study of SCORBOT-ERV robot

2.   Repeatability test for SCORBOT ER-V robot

3.   Study of SCORBOT ER-14 robot

4.   Repeatability test of SCORBOT ER-14 robot

5.   Study of GRYPHON robot

6.   Study of MENTOR robot

7.   Positional accuracy of MENTOR robot

8.   Backlash measurement of MENTOR robot

9.   Repeatability test for MENTOR robot

10.   Spatial resolution test of MENTOR robot

11.   Study of IGRIP simulation package

12.   Study of CNC Milling and CNC Drilling machines.

13.   Automated component inspection using vision System.

TOTAL: 45

12MF10 SUPPLY CHAIN MANAGEMENT

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INTRODUCTION (6)

Definition of Logistics and SCM: Evolution, Scope, Importance and Decision Phases – Drivers of SC Performance and Obstacles.

LOGISTICS MANAGEMENT (10)

Factors – Modes of Transportation - Design options for Transportation Networks-Routing and Scheduling – Inbound and outbound logistics- Reverse Logistics – 3PL- Integrated Logistics Concepts- Integrated Logistics Model – Activities - Measuring logistics cost and performance – Warehouse Management - Case Analysis

SUPPLY CHAIN NETWORK DESIGN (10)

Distribution in Supply Chain – Factors in Distribution network design –Design options-Network Design in Supply Chain – Framework for network Decisions - Managing cycle inventory and safety.

SOURCING AND PRICING IN SUPPLY CHAIN (9)

Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management in supply chain

COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN (10)

Supply chain coordination - Bullwhip effect – Effect of lack of co-ordination and obstacles – IT and SCM - supply chain IT frame work - E-Business and SCM - Metrics for SC performance – Case Analysis

TOTAL: 45

References:

1. *Sunil Chopra and Peter Meindl **"Supply Chain Management Strategy, Planning, and Operation"**, PHI, Second Edition, 2007*

2. *David J.Bloomberg, Stephen Lemay and Joe B.Hanna "**Logistics"**,, PHI 2002*

3. *Martin Christopher, **"Logistics and Supply Chain Management"**, Strategies for Reducing Cost and Improving Service. Pearson Education Asia, Second Edition*

4. *Jeremy F.Shapiro, Thomson Duxbury, **"Modeling the Supply Chain"**, 2002*

5. *James B.Ayers, **"Handbook of Supply Chain Management"**, St.Lucle Press, 2000*

12MF13 ADVANCED MAINTENANCE MANAGEMENT

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MAINTENANCE CONCEPT (7)

Maintenance objectives and functions – Tero technology – Five zero concept – Maintenance costs and budgets – Maintenance organization.

FAILURE DATA ANALYSIS (9)

MTBF, MTTF, useful life – Survival curves – repair time distribution – exponential, Poisson, normal, Weibull applications – Standby systems - Availability of repairable systems – Maintainability prediction – Design for maintainability.

MAINTENANCE MODELS (10)

Maintenance policies – Imperfect maintenance – concept of minimal repair – Statistical aids for PM and break-down maintenance – PM schedules: deviations on both sides of target values – PM schedules for functional characteristics and large scale system – replacement models – DOM, opportunistic maintenance – Inspection and repair - Spare parts management.

TOTAL PRODUCTIVE MAINTENANCE (10)

TPM philosophy – Policy and objectives – Pillars - Zero breakdown – loss prevention – Overall Equipment Effectiveness (OEE) – Failure Mode Effect Analysis (FMEA) – Risk Priority Number (RPN).

ADVANCED TECHNIQUES

(9)

Condition monitoring: WDM, Vibration and corrosion monitoring – Signature analysis – MMIS – Expert systems – Reliability centered maintenance (RCM)

TOTAL : 45

References:

1. *Gopalakrishnan, P. Banerji, A.K. "**Maintenance and spare parts management**", Prentice Hall of India, 1991.*

2. *Edward Hartmann, "**Maintenance Management**", Productivity and Quality publishing Pvt.Ltd. Madras, 1995.*

3. *Seichi Nakagima, "**Introduction to Total Productive Maintenance**", Productivity Press (India) Pvt.Ltd.,1993*

12MF14 RAPID PROTOTYPING AND TOOLING

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INTRODUCTION (9)

Rapid Product Development (RPD) –Product Development Cycle – Detail design– Prototype and tooling.

RAPID PROTOTYPING (RP) (9)

Principle of RP technologies and their classification of RP systems–Stereo lithography systems – Selection of RP process; Issues in RP ; Emerging trends–Direct Metal Laser Sintering (DMLS) system – Principle – process parameters – process details – Applications.

(9)

ENGINEERING PROCESS

Fusion Deposition Modeling –Laminated Object Manufacturing –Selective Laser Sintering- Three dimensional Printing-Reverse Engineering -Engineering applications–Medical applications.

PROCESSING POLYHEDRAL DATA (9)

Polyhedral BRep modeling–STL format– Defects and repair of STL files– Processing STL files; Overview of the algorithms required for RPANDT- slicing, support generation, feature recognition

RAPID TOOLING (9)

Introduction to RT–Indirect RT processes – Silicon rubber molding, Epoxy tooling, Spray metal tooling and Investment Casting; Direct RT processes – Laminated Tooling, Powder Metallurgy based technologies, Welding based technologies, Direct pattern making (Quick Cast, Full Mold Casting); Emerging Trends in RT

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TOTAL: 45

References:

1. *Terry wohlers, Wohlers Report 2000, Wohlers Associates, USA, 2000.*

2. *Chua Chee Kai and Leong Kah Fai, 1997, **"Rapid Protoyping: Principles and Applications in Manufacturing"**, John Wiley AND Sons*

3. *Paul F. Jacobs, 1996, **"Stereo-lithography and other RP & M Technologies"**: from Rapid Prototyping to Rapid Tooling, SME/ASME*

4. *D. Faux and M. J. Pratt, 1979, **"Computational Geometry for Design and Manufacture"**, John Wiley and Sons*

5. *Pham, D.T. & Dimov.S.S., **"Rapid manufacturing"**, Springer-Verlag, London, 2001.*

12MF15 DIAGNOSTIC TECHNIQUES

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DEFECTS AND FAILURE ANALYSIS (7)

Defect generation-types of failures-Defects reporting and recording-Defect analysis-Failure analysis-Equipment down time analysis-Breakdown analysis-TA,FMEA, FMECA.

MAINTENANCE SYSTEMS (8)

Planned and unplanned maintenance-Breakdown maintenance-Corrective maintenance-Opportunistic maintenance-Routine maintenance-Preventive maintenance, Predictive maintenance-Condition based maintenance system-Design out maintenance-selection of maintenance system.

SYSTEMATIC MAINTENANCE (10)

Codification and Cataloguing-Instruction manual and operating manual-Maintenance manual and Departmental manual-Maintenance time standard-Maintenance work order and work permit -job monitoring-Feedback and control-Maintenance records and documentation.

COMPUTER MANAGED MAINTENANCE SYSTEM (8)

Selection and scope of computerization-Equipment classification-Codification of breakdown, material and facilities-Job sequencing-Material management module-Captive Engineering module.

CONDITION MONITORING (12)

Condition monitoring techniques-Visual monitoring-Temperature monitoring-vibration monitoring-Lubricant monitoring-Cracks monitoring-Thickness monitoring-Noise and sound monitoring-condition monitoring of hydraulic system. Machine diagnostics-Objectives-Monitoring strategies-Examples of monitoring and Diagnosis - Control structures for machine diagnosis.

TOTAL: 45

References:

1. *Sushil Kumar Srivastava, "**Industrial Maintenance Management**", S.Chand and company Ltd., New Delhi, 2011.*

2. *Manfred Weck, H.Bibring, "**Handbook of Machine Tools,Vol 3.**", John Wiley and Sons.*

3. *Garg H.P, "**Industrial Maintenance**", S.Chand & company Ltd., NewDelhi, 2009.*

12MF16 ADVANCED FINITE ELEMENT METHODS

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INTRODUCTION (9)

Modeling and Discretization – Interpolation, Elements, Nodes and degrees-of-freedom. Computational Procedures– Stiffness Matrices – Boundary Conditions-Solution of Equations- Ritz method, Variational Method, Method of weighted residuals.

BASIC ELEMENTS (9)

Interpolation and shape functions - element matrices-linear triangular elements (CST)-quadratic triangular elements – bilinear rectangular elements-quadratic rectangular elements-solid elements-higher order elements-nodal loads-stress calculations-example problems.

ISOPARAMETRIC ELEMENTS (9)

Introduction-bilinear quadrilateral elements – quadratic quadrilaterals – hexahedral elements – Determination of Shape Functions - Numerical Integration – quadrature - static condensation – load considerations – stress calculations – examples of 2D and 3D applications.

FINITE ELEMENT FORMULATION FOR STRUCTURAL APPLICATIONS (9)

Linear elastic stress analysis-2D, 3D and axisymmetric problems – Analysis of structural vibration – mass and damping matrices – damping – Harmonic response – direct integration techniques – explicit and implicit methods.

HEAT TRANSFER AND FLUID MECHANICS APPLICATIONS (9)

Nonlinear Problems – Element formulation – Heat Conduction, Fluid flow, etc–Transient Thermal Analysis-Acoustic frequencies and modes- Incompressible and rotational flows.

TOTAL: 45

References:

1. *Cook, Robert Davis et al **"Concepts and Applications of Finite Element Analysis",** Wiley, John & Sons, 1981.*

2. *O.C Zienkiewicz, **"The Finite Element Method"**, 3rd Edition, Tata McGraw-Hill, 2005.*

3. *C.S. Desai and J.F. Abel, **"Introduction to Finite Element Method"**, Affiliated East-West Press, 1972.*

4. *Chandrupatla, Belagundu, **"Finite Elements in Engineering"**, Prentice Hall of India Private Ltd., 2002.*

12MF17 NON DESTRUCTIVE EVALUATION

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BASIC CONCEPTS OF NDT   **(9)**

Relative merits and limitations of NDT Vs. Conventional testing –Visual inspection, thermal inspection methods. Liquid penetrant Inspection.

LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS   **(9)**

Characteristics of liquid penetrants - different washable systems - Developers - applications - Methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications - Advantages and limitations.

RADIOGRAPHY   **(9)**

Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES   **(9)**

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

THERMOGRAPHY   **(9)**

Thermography - Principles, types, applications, advantages and limitations. Optical and Acoustical holography- Principles, types, applications, advantages and limitations. Casestudies: weld, cast and formed components.

                                                         TOTAL: 45

References:

1. *Barry Hull and Vernon John, **"Non Destructive Testing"**, MacMillan, 1988.*

2. *American Society for Metals, "**Metals Hand Book"**, Vol.II, 1976.*

3. *Hull. **"Non Destructive Testing"**. ELBS Edition. 1991.*

4. *Baldevraj., Jayakumar.T., Thavasimuthu. M., **"Practical Non-destructive Testing"**, Narosa Publishers, 1997.*

5. *McGonnagle. W.T. **"Non-Destructive Testing"**, McGraw Hill. 1961.*

6. *ASM Metals Hand Book. Vol. 9. **"Non-destructive Testing and Inspection"**, 1988.*

12MF18 FLUID POWER CONTROL AND AUTOMATION

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OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS (8)

Hydraulic Power Generators – Selection and specification of pumps- types of pumps- pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

CONTROL AND REGULATION ELEMENTS (8)

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

HYDRAULIC CIRCUITS (10)

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits – regenerative and High-low circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning – hydraulic copying circuit - forklift and other earth mover circuits- design and selection of components.

PNEUMATIC SYSTEMS AND CIRCUITS (10)

Pneumatic fundamentals - control elements- position and pressure sensing - logic circuits - switching circuits - sequential circuits - cascade method – step counter method - KV mapping method - compound and combinational circuit designs.

INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS (9)

Pneumatic equipment- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors and PLC for sequencing -Robotic circuits. Introduction to Software for pneumatic / hydraulic systems simulation.

TOTAL: 45

References:

1. *Antony Espossito, "**Fluid Power with Applications**", Prentice Hall, 2000.*

2. *Dudleyt, A. Pease and John J. Pippenger, "**Basic Fluid power**", Prentice Hall, 1987.*

3. *Michael J., Pinches and John G.Ashby, "**Power Hydraulics**", Prentice Hall, 1989.*

4. *Bolton. W., "**Pneumatic and Hydraulic Systems**", Butterworth –Heinemann, 1997.*

5. *Joji P., "**Pneumatic Controls**", Wiley India Pvt. Ltd., New Delhi, 2008.*

6. *Andrew Parr, "**Hydraulic and Pneumatics**" (HB), Jaico Publishing House, 1999.*

7. *http:// www.pneumatics .com*

8. *http:// www.fluidpower.com.tw*

12MF19 INDUSTRIAL ERGONOMICS

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INTRODUCTION (9)

Concepts of human factors engineering and ergonomics – Man – machine system and design philosophy – Physical work – Heat stress – manual lifting – work posture –repetitive motion.

ANTHROPOMETRY (9)

Physical dimensions of the human body as a working machine – Motion size relationships – Static and dynamic anthropometry – Anthropometric aids – Design principles – Using anthropometric measures for industrial design – Procedure for anthropometric design.

DESIGN OF SYSTEMS (9)

Displays – Controls – Workplace – Seating – Work process – Duration and rest periods– Hand tool design – Design of visual displays – Design for shift work.

ENVIRONMENTAL FACTORS IN DESIGN (9)

Temperature – Humidity – Noise – Illumination –Vibration – Measurement of illumination and contrast – use of photometers – Recommended illumination levels. The ageing eye– Use of indirect (reflected) lighting – cost efficiency of illumination – special purpose lighting for inspection and quality control – Measurement of sound – Noise exposure and hearing loss – Hearing protectors – analysis and reduction of noise – Effects of Noise on Performance – annoyance of noise and interference with communication – sources of vibration discomfort.

WORK PHYSIOLOGY (9)

Provision of energy for muscular work – Role of oxygen physical exertion –Measurement of energy expenditure Respiration – Pulse rate and blood pressure during physical work – Physical work capacity and its evaluation.

TOTAL: 45

References:

1. Martin Helander, "A guide to the ergonomics of manufacturing", East West press, 1996

2. E.J. McCormic, "Human factors in engineering design", McGraw Hill 1976

3. R.S. Bridger, "Introduction to Ergonomics", McGraw Hill, 1995.

12MF20 OPTIMIZATION TECHNIQUES IN ENGINEERING

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INTRODUCTION (5)

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

CLASSIC OPTIMIZATION TECHNIQUES (10)

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

NON-LINEAR PROGRAMMING (9)

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming

INTEGER PROGRAMMING, DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES (12)

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

ADVANCES IN SIMULATION (9)

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 45 PERIODS

References:

1. R. Panneerselvam, *"Operations Research"*, Prentice Hall of India Private Limited, New Delhi 1, 2005

2. P.K. Guptha and Man-Mohan*, "Problems in Operations Research"* – Sultan Chand & Sons, 1994

3. Ravindran, Philips and Solberg, *"Operations Research Principles and Practice"*, John Wiley & Sons, Singapore, 1992

4. J.K.Sharma, *"Operations Research – Theory and Applications"* – Macmillan India Ltd., 1997

5. Hamdy A. Taha *"Operations Research – An Introduction"*, Prentice Hall of India, 1997

12MF21 ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

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KNOWLEDGE REPRESENTATION FOR SMART SYSTEMS (9)

Concepts of fifth generation computing -. Forward chaining, backward chaining, use of probability and fuzzy logic. Semantic nets, structure and objects, ruled systems for semantic nets; certainty factors, automated learning.

LANGUAGES USED IN AI (9)

Programming in AI environment - developing artificial intelligence system, natural language processing, neural networks Using PROLOG to design expert systems, converting rules to PROLOG, conceptual example, introduction to LISP, function evaluation, lists, predicates, rule creation.

EXPERT SYSTEM DEVELOPMENT (9)

Definition, choice of domain, collection of knowledge base, selection of inference mechanism, case studies of expert system development in design and manufacturing -Expert systems, controlling reasoning, rule based system, canonical systems, rules and meta rules, associative nets and frame systems, graphs trees and networks, representing uncertainity, probability in expert systems-learning, forms of learning, inductive learning.

EXPERT SYSTEM TOOLS (9)

Decision trees, knowledge in learning, heuristic classification, heuristic matching, case studies in expert systems, MYCIN, Meta- Dendral, general structure of an expert system shell, examples of creation of an expert system using an expert system tool, fundamentals of object oriented programming, creating structure and object, object operations, invoking procedures, programming applications, object oriented expert system.

INDUSTRIAL APPLICATION OF AI AND EXPERT SYSTEMS (9)

Robotic vision systems, image processing techniques, application to object recognition and inspection, automatic speech recognition – applications in automotive industries and nuclear power projects.

TOTAL: 45

References:

1. *Robert Levine et al, "**A Comprehensive Guide to AI and Expert Systems**", McGraw Hill Inc, 1988.*

2. *Henry C Mishkoff, "**Understanding AI**", BPB Publication, New Delhi, 1986.*

3. *Peter Jackson, "**Introduction to Expert Systems**", First Indian Reprint, 2000, Addison, Wesley.*

4. *Stuart Russell and Peter Norvig, "**Artificial Intelligence: A Modern Approach**", Prentice Hall, 1995.*

5. *Elaine Rich et al., "**Artificial Intelligence**", McGraw Hill, 1995.*

6. *Winston P H, "**Artificial Intelligence**", Addison Wesley, Reading, Massachusetts, Third Edition, 1992*

12MF22 RELIABILITY AND QUALITY ENGINEERING

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QUALITY CONCEPTS (7)

Quality objectives - Quality control - Quality Assurance - Quality systems, economics, Statistical tolerancing - Quality loss function.

STATISTICAL PROCESS CONTROL (10)

Process variability - Control charts for variables and attributes, Moving average control charts, multivarichart- Cumulative chart - demerit control chart - process capability studies.

DESIGN OF EXPERIMENTS (10)

Factorial experiments - fractional replication - Taguchi methods - Use of orthogonal arrays –Response surface methodology- Cases.

RELIABILITY AND QUALITY MANAGEMENT (10)

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) – A priori and a posteriori concept - mortality curve – useful life – availability – maintainability – system effectiveness Reliability prediction and testing - Quality circles - Zero defects program - ISO 9000 and TQM - Total quality organisation.

RELIABILITY MANAGEMENT AND RISK ASSESSMENT (8)

Reliability testing – Reliability growth monitoring – Non-parametric methods – Reliability and life cycle costs – Reliability allocation – Replacement model-Definition and measurement of risk – risk analysis techniques – risk reduction resources – industrial safety and risk assessment.

TOTAL: 45

References:

1. *Logothetis.N, "Managing for total quality from Deming to Taguchi and SPC", PHI, 1997.*

2. *Fiegenbarum.A.V, "Total Quality Control", McGraw Hill Inc., 1991.*

3. *Douglas, C.Montgomery, "Introduction to Statistical quality control", Second Edition John Wiley AND Sons, 1991.*

4. *Srinath L.S, "Reliability Engineering", Affiliated East-West Press Pvt Ltd, New Delhi, 1998.*

5. *Modarres, "Reliability and Risk analysis", Maral Dekker Inc.1993.*

6. *Dale H.Besterfield, "Quality Improvement", PHI, 2010.*

12MF23 ADVANCED TOOL DESIGN

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TOOL-DESIGN METHODS (5)

Introduction – The Design Procedure – Statement of the problem – The Needs Analysis – Research and Ideation – Tentative Design Solutions – The Finished Design – Drafting and Design Techniques in Tooling drawings – Screws and Dowels – Hole location – Jig-boring practice – Installation of Drill Bushings – Punch and Die Manufacture – Electro-discharge machining – Electro-discharge machining for cavity.

TOOLING MATERIALS AND HEAT TREATMENT (9)

Introduction – Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron – Mild, or low-carbon Steel – Nonmetallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools – Single-point cutting tools – Milling cutters – Drills and Drilling – Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools.

DESIGN OF DRILL JIGS (9)

Introduction – Fixed Gages – Gage Tolerances – The selection of material for Gages – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Drill jigs and modern manufacturing.

DESIGN OF FIXTURES AND DIES (13)

Introduction – Fixtures and economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Types of Die construction – Die-design fundamentals – Blanking and Piercing die construction – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing operations.

TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS (9)

Introduction – The need for numerical control – A basic explanation of numeric control – Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction – General explanation of the Brown and sharp machine – tooling for Automatic screw machines

TOTAL: 45

References:

1. *Cyrll Donaldson, George H.LeCain, V.C. Goold, "**Tool Design**", Tata McGraw Hill Publishing Company Ltd., 2000.*

2. *Prakash Hiralal Joshi, "**Tooling data**", Wheeler Publishing, 2000*

3. *www.irdi.on.ca/irdi/front.htm*

4. *www.techsolve.org/flashhome.htm*

12MF24   COMPOSITE MATERIALS

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INTRODUCTION   (9)

Fundamentals of composites- need for composites- classifications of composites- Matrix-Polymer matrix composite (PMC),Metal matrix composites(MMC),Ceramic matrix composites(CMC), Graphite matrix composites- Reinforcement- Particle reinforced composites, Fibre reinforced composites. Types of fibre and resin materials and their properties- Advantages and applications of various types of composites.

BASIC CONCEPTS   (9)

Hooke's law for orthotropic and anisotropic materials-Governing equations for orthotropic and anisotropic plates- Micromechanics and Macro mechanics-Lamina- Laminates- Angle ply and cross ply Laminates - Lamina stress-strain relations.

ANALYSIS OF LAMINATED COMPOSITES   (9)

Static, dynamic and stability analysis for simpler cases of laminated composite plates- inter laminar stresses.

ANALYSIS AND FAILURE THEORY   (9)

Netting analysis- Failure criteria- Sandwich construction.

PROCESSING OF METAL MATRIX COMPOSITES AND CERAMIC MATRIX COMPOSITES   (9)

Solid state fabrication techniques – diffusion bonding – powder metallurgy techniques plasma spray, chemical and physical vapour deposition of matrix on fibres Chemical vapour infiltration – liquid state fabrication methods – infiltration – squeeze and stir casting – rheo casting – compo casting - Interfaces properties– application of MMC and ceramic matrix composites.

TOTAL: 45

References:

1. *R.M. Jones, "**Mechanics of Composite Materials**", 2nd Edition, Taylor & Francis, 1999*

2. *L.R. Calcote, "**Analysis of laminated structures**", Van Nostrand Reinhold Co., 1989*

3. *G.Lubin, "**Hand Book on Fiber Glass and Advanced Plastic Composites**", Van Nostrand Co., New York, 1989.*

4. *B.D. Agarwal and L.J. Broutman, "**Analysis and Performance of Fiber Composites**", John-Wiley and Sons, 1990.*

5. *Autar K. Kaw, "**Mechanics of Composite Materials**", CRC Press LLC, 1997*

12MF25 CORROSION AND SURFACE ENGINEERING

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MECHANISMS AND TYPES OF CORROSION (9)

Principles of direct and Electro chemical Corrosion, Hydrogen evolution and Oxygen absorption mechanisms – Galvanic corrosion, Galvanic series-specific types of corrosion such as uniform, Pitting, Intergranular, Cavitations, Crevice Fretting, Erosion and Stress Corrosion –Factors influencing corrosion

TESTING AND PREVENTION OF CORROSION (9)

Corrosion testing techniques and procedures- Prevention of Corrosion-Design against corrosion –Modifications of corrosive environment –Inhibitors – Cathodic Protection –Protective surface coatings.

CORROSION BEHAVIOR OF MATERIALS (9)

Corrosion of steels, stainless steel, Aluminum alloys, copper alloys, Nickel and Titanium alloys- corrosion of Polymers, Ceramics and Composite materials.

SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE (9)

Diffusion coatings –Electro and Electroless Plating –Hot dip coating –Hard facing-Metal spraying, Flame and Arc processes-Conversion coating –Selection of coating for wear and Corrosion resistance.

THIN LAYER ENGINEERING PROCESSES (9)

Laser and Electron Beam hardening –Effect of process variables such as power and scan speed - Physical vapor deposition, Thermal evaporation, Arc vaporization, Sputtering, Ion plating - Chemical vapor deposition – Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating – Properties and applications of thin coatings.

TOTAL: 45

References:

1. *Fontana. G., "Corrosion Engineering", McGraw Hill, 1985.*

2. *Serope Kalpakjian, "Manufacturing Engineering and Technology" Addison Wesley Publishing Co; New York 1995.*

3. *Schweitzer. P.A., "Corrosion Engineering Hand Book", 3rd Edition, Marcel Decker, 1996.*

4. *Winston Revie.R. Uhlig, Corrosion, Hand Book 2nd Edition. John Wiley, 2000.*

5. *Kenneth G.Budinski, "Surface Engineering for Wear Resistance", Prentice hall, 1988.*

6. *ASM Metals Hand Book –Vol. 5, "Surface Engineering", 1996.*

12MF26 ADVANCES IN CASTING AND WELDING PROCESSES

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CASTING METALLURGY AND DESIGN (9)

Heat transfer between metal and mould – Solidification of pure metal and alloys – Shrinkage in cast metals – progressive and directional solidification – Principles of grating and restring – Degasification of the melt – Design considerations in casting – Designing for directional solidification and minimum stresses – casting defects

SPECIAL CASTING PROCESSES (9)

Shell moulding – Precision investment casting – CO_2 – moulding – centrifugal casting – Die casting – Continuous casting.

WELDING METALLURGY AND DESIGN (12)

Heat affected Zone and its characteristics – Weldability of steels, cast iron, Stainless steel,aluminum and Titanium alloys – Hydrogen embrittlement – Lamellar tearing – Residual stress – Heat transfer and Solidification – Analysis of stresses in welded structures – pre and post welding heat treatments – Weld joint design – Welding defects – testing of weldment.

UNCONVENTIONAL AND SPECIAL WELDING PROCESSES (6)

Friction welding – Explosive welding – Diffusion bonding – High frequency Induction welding – Ultrasonic welding – Electron beam welding – Laser beam welding

RECENT ADVANCES IN CASTING AND WELDING (9)

Layout of mechanised foundry – sand reclamation – Material handling in foundry – pollution control in Foundry – Recent trends in casting – Computer Aided design of Castings, Low pressure die casting, Squeeze casting and full mould casting process – Automation in welding – Welding robots – Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

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References:

1. R. W. Ruddle, "**Solidification of Castings, Institute of Metals**", *London, 1957.*

2. J. Campbell, "**Casting**", *Butterworkth Heineman, Oxford, 1993.*

3. Schwartz, M.M., "**Metal Joining Manual**", *McGraw Hill, NY, 1979.*

4. Titoun.D. and Stepanov .YU.A., **"Foundry Practice"**, *MIR Publishers, 1981.*

5. Iotrowski, **"Robotic welding – A guide to selection and application"**, *Society of Mechanical Engineers, 1987.*

6. Cornu. J., **"Advanced Welding systems"**, *Volumes I,II and III, JAICO Publishers, 1994.*

7. Lancaster. J.F., "**Metallurgy of Welding**", *George Allen and Unwin Publishers, 1980.*

8. Serope Kalpakjian*, "**Manufacturing Engineering and Technology**" Third Edition, Addison Wesley Publishing Co.1995*

9. P.N.Rao, "**Manufacturing Technology (Foundry, Forming and Welding)**", *Second Edition*, **, Tata McGraw Hill Pub.Co. Ltd, 2004.*

12MF27 INDUSTRIAL SAFETY MANAGEMENT

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SAFETY MANAGEMENT (9)

Evaluation of modern safety concepts - Safety management functions - safety organization, safety department - safety committee, safety audit - performance measurements and motivation - employee participation in safety - safety and productivity.

OPERATIONAL SAFETY (9)

Hot metal Operation - Boiler, pressure vessels - heat treatment shop - gas furnace operation - electroplating-hot bending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machine shop - Cold bending and chamfering of pipes - metal cutting - shot blasting, grinding, painting - power press and other machines.

SAFETY MEASURES (9)

Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments, on- site and off site. Control of major industrial hazards.

ACCIDENT PREVENTION (9)

Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees - First Aid- Fire fighting devices - Accident reporting, investigation.

SAFETY, HEALTH, WELFARE AND LAWS (9)

Safety and health standards – OHAS Industrial hygiene - occupational diseases prevention - Welfare facilities - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

TOTAL: 45

References:

1. *John V. Grimaldi and Rollin H. Simonds, "**Safety Management**", All India Travellers bookseller, New Delhi-1989.*

2. *Krishnan N.V., "**Safety in Industry**", Jaico Publisher House, 1996.*

3. ***Occupational Safety Manual** BHEL.*

4. ***"Industrial safety and the law"** by P.M.C. Nair Publisher's, Trivandrum.*

5. ***"Managing emergencies in industries"**, Loss Prevention of India Ltd., Proceedings, 1999.*

6. ***"Safety security and risk management"** by U.K. Singh & J.M. Dewan, A.P. Publishing company, New Delhi, 1996.*

7. *Singh,U.K and Dewan.J.M, "**Safety, Security and Risk management**", APH PublishingCompany, New Delhi, 1996*

12MF28 MEMS AND NANO TECHNOLOGY

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OVERVIEW OF MEMS AND MICROSYSTEMS (8)

Definition – historical development – fundamentals – properties, micro fluidics, design and fabrication micro-system, microelectronics, working principle and applications of micro system, MEMS Simulation and Design tools-Behavioral model ling simulation tools and Finite element simulation tools.

MATERIALS, FABRICATION PROCESSES AND MICRO SYSTEM PACKAGING (9)

Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers. Photolithography, photo resist applications, light sources, in implantation, diffusion process exudation – thermal oxidation, silicon diode, chemical vapour deposition, sputtering - deposition by epitoxy – etching – bulk and surface machining – LIGA process Micro system packaging – considerations packaging – levels of micro system packaging die level, device level and system level.

MICRO DEVICES AND MATERIALS (9)

Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – displacement sensors, pressure and flow sensors, micro actuators – smart materials – applications.

SCIENCE OF NANO MATERIALS (9)

Classification of nano structures – effect of the nanometer length scale effects of nanoscale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties – effect of nanoscale dimensions on biological systems. Fabrication methods – Top down processes – bottom up process.

CHARACTERIZATION OF NANO MATERIALS (10)

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

TOTAL: 45

References:

1. *Tai – Ran Hsu, "**MEMS and Microsystems Design and Manufacture**", Tata-McGraw Hill, New Delhi, 2002.*
2. *Mark Mado, "**Fundamentals of Microfabrication**", CRC Press, New York, 1997.*
3. *Norio Taniguchi, "**Nano Technology**", Oxford University Press, New York, 2003*
4. *Mohamed Gad-el-Hak, "**The MEMS Hand book**", CRC Press, New York, London.*
5. *Charles P Poole, Frank J Owens, "**Introduction to Nano technology**", John Wiley and Sons, 2003*
6. *Julian W. Hardner , "**Micro Sensors, Principles and Applications**", CRC Press 1993.*
7. *Stephen Beeby, Graham Ensell, Michael Kraft and Neil White, "**MEMS Mechanical Sensors**" Artech House, Inc. Boston 2003.*

12MF29 TESTING, INSPECTION AND QUALITY CONTROL OF WELDMENTS

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DESTRUCTIVE TESTING OF WELDMENTS (6)

Tensile tests, impact tests, all-weld – metal tests, COD test, transverse test, Nick-break test, bend tests, hardness tests, hot cracking tests, cold cracking tests, transition temperature test – Experimental stress analysis.

BASIC CONCEPTS OF NDT (9)

Relative merits and limitations of NDT Vs. Conventional testing – Visual inspection, thermal inspection methods. Liquid penetrant Inspection: Principles, applications advantages and limitations, Dyes, developers and cleaners, fluorescent penetrant test application of liquid penetrant testing to weldments.Magnetic Particle Inspection: Principle, application, magnetization methods – magnetic particles, dry and wet technique, demagnetization. Principles, application and Instrumentation of Eddy current testing.

X-RAY RADIOGRAPHY (12)

Types of radiation, properties of X-rays relevant to NDE, absorption of X-rays, scattering, types and use of filters and screens, geometric factors, inverse square law, film types and processing, characteristics of films – grain fineness, density, speed contrast characteristics curves, penetrameters, Exposure charts, radiographic equivalence.Gamma ray Radiography:Gamma ray sources, comparison with X ray radiography radioactive decay, artificial radioactivity, characteristics of Gamma ray sources, Gamma exposure chart. Measurement of radioactivity, radiation hazards, units of radiation dose measurement, permissible radiation dose, radiation detection and measurement instruments, protection against radiation. Brief description of fluoroscopy, gamma radiography. Standard radiographys, Interpretation of radiographs, application of radiographic testing to weldments.

ULTRASONICS (10)

Types of ultrasonics waves, principles of wave propagation characteristics of ultrasonic waves, attenuation, production of ultrasonic waves, couplants. Inspection methods – pulse echo, transmission and resonance, thickness measurement. Types of scanning, test blocks IIW reference block. Calibration of Ultrasonic equipment, application of ultrasonic testing to weldments. Holography, acoustic emission techniques – Miscellaneous techniques like leak testing, pressure testing, chemical spot testing, spark testing.

INSPECTION AND QUALITY CONTROL (8)

Principles of inspection, inspection organization, qualification of inspectors, authority and responsibility, quantum of inspection, types of inspection, statistical quality control. Welding procedure specification, procedure qualification records, performance qualification, variables.

TOTAL: 45

References:

*1. Hull, "**Non Destructive Testing**", ELBS Edition, 1991.*

*2. Baldevraj, Jayakumar.T, Thavasimuthu.M, "**Practical Non-destructive Testing**", Narosa Publishers, 1997.*

3. *McGonnagle.W.T, "**Non-Destructive Testing**", McGraw Hill, 1961.*

4. *Nadkarni.S.V, "Modern **Arc Welding Technology**", Oxford IBH, 1996.*

5. *Montgomery.C.Douglus, "**Introduction to Statistical Quality Control**", 2nd Edition, John Wiley and Sons, 1991.*

6. *Mohamed Zairi, "**Total Quality Management for Engineers**", Woodhead Publishing Limited, 1991.*

7. *ASM Metals HandBook, Vol.9, "**Non-destructive Testing and Inspection**", 1988.*

12MF30 LEAN MANUFACTURING SYSTEMS AND IMPLEMENTATION

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LEAN MANUFACTURING (7)

Evolution of Lean, Traditional versus Lean Manufacturing, Business of Survival and Growth, Business Model Transformation, Ford Production System, Job Shop Concepts Concept of Lean, Toyota's foray in Lean.

DESIGN - VALUE STREAM MANAGEMENT (9)

Definition, VSM Types, Product Family Selection, Value Stream Manager; Current State Map, Process Box, Value Stream Icons, 3 Ms - Muda, Mura, Muri - 7 Types of Muda, Future State Map, Value Stream Plan, Process Stability - Loss Reduction 7 Major Losses Reduction. Demand Stage, Market Dynamics, Customer Demand, PQ Analysis, PR Analysis; TAKT Time, Pitch, Finished Goods Stock, Cycle Stock, Buffer Stock, Safety Stock.

FUNDAMENTAL LEAN TOOLS (11)

Flow Stage, Continuous Flow, Cell Layout, Line Balancing, Macro and Micro Motion, Analysis, Standardized Work, Concept of Kaizen, Steps involved in Kaizen Deployment, Industrial Engineering - Concepts and Fundamentals, Kanban Concepts, Types of Kanbans and Practical Application, Concept of Pull, Changeover Time Reduction - External AND Internal, Single Minute Exchange of Die, Quick Die Change, Quality-Vendor, In Process and Customer, Line.

LEAN IMPLEMENTATION (9)

Concept of PPM, Pokayoke, Prevention and Detection Types, Maintenance - Preventive, Time Based and Condition Based; Human Development for Lean (Training and Involvement through Autonomous Maintenance) Leveling Stage of Lean Implementation, Production Leveling , Leveling Box, Concept of Water Spider.

LEAN METRICS AND LEAN SUSTENANCE (9)

Identify Lean Metrics, Steps involved in Goal Setting; Corporate Goals, Kaizen Cloud, identification in VSM, Lean Assessment, Cultural Change, Reviews, Recognition, Improving Targets and Benchmarks.

TOTAL: 45

References:

1. *Askin R G and Goldberg J B, **"Design and Analysis of Lean Production Systems"**, John Wiley & Sons, New York, 2003.*

2. *Don Tapping, Tom Luyster and Tom Shuker,"**Value Stream Management"** Productivity Press, 2002.*

3. *Tom Luyster and Don Tapping, "**Creating Your Lean Future State: How to Move from Seeing to Doing**", Productivity Press, 2006.*

4. *Mike Rother and Rick Harris, "**Creating Continuous Flow**", Publisher: Lean Enterprise Institute, Inc., 2001.*

5. *Rick Harris, Chris Harris & Earl Wilson, "**Making Materials Flow**", Publisher: Lean Enterprise Institute, Inc., 2003.*

6. *Micheal Wader, "**Lean Tools: A Pocket guide to Implementing Lean Practices**", Productivity and Quality Publishing Pvt Ltd, 2002.*

12MF31 VIBRATION CONTROL AND CONDITION MONITORING

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INTRODUCTION (9)

Review of Fundamentals of single Degree Freedom systems-Two Degree Freedom systems, Multi Degree Freedom systems, Continuous systems, Determination of Natural frequencies and mode shapes, Numerical methods in Vibration Analysis.

VIBRATION CONTROL (9)

Introduction-Reduction of Vibration at the source-Control of vibration-by structural design-Material selection- Localized additions-Artificial Damping-Resilient isolation, Vibration isolation, Vibration absorbers.

ACTIVE VIBRATION CONTROL (9)

Introductions - Concepts and Applications, Review of smart materials-Types and characteristic review of smart structures - Characteristic Active vibration control in smart structures.

CONDITION BASED MAINTENANCE PRINCIPLES AND APPLICATIONS (9)

Introduction-condition monitoring methods- Design of Information system, Selecting methods of monitoring, Machine condition monitoring and diagnosis-Vibration severity criteria-Machine Maintenance Techniques-Machine condition monitoring techniques-Vibration monitoring techniques-Instrumentation systems-choice of monitoring parameter.

DYNAMIC BALANCING AND ALIGNMENT OF MACHINERY (9)

Introduction, Dynamic balancing of Rotors, Field Balancing in one plane, Two planes and in several planes, Machinery alignment, Rough Alignment methods, The Face Peripheral Dial Indicator Method, Reverse indicator Method, Shaft-to-coupling spool method

TOTAL: 45

References:

1. *Singiresu S.Rao, "**Mechanical vibrations**", Addison - Wesley Publishing Co., 1995.*

2. *K.J.Bathe and F.I., Wilson, "**Numerical Methods in Finite Element Analysis**" -   Prentice Hall of India Pvt.m, Ltd., 1978.*

3. *J.O.Den Hartog, "**Mechanical Vibrations**"-McGraw Hill, NMewYork, 1985.*

4. *Rao J S, "**Vibratory Condition Monitoring of Machines**", Narosa Pubulishing House, 2000.*

12MF32 FINANCIAL MANAGEMENT AND COST ACCOUNTING

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TECHNIQUES OF INVESTMENT ANALYSIS (9)

Payback period method, Accounting Rate of Return, Introduction to Discounting and cash flows estimation, DCF methods, IRR, NPV, PI, Discounted payback methods, DCF method compared- conflicts resolution-Leasing and Lease evaluation.

FINANCING DECISION (9)

Cost of capital, cost of equity, Debt, convertible Debentures, preference share capital, Minimum rate of return, capital structure, Optimum capital structure, Traditional theory, MM theory, corporate debt capacity, Indifference point.

DIVIDEND DECISION (9)

Dividend policy, Gordon's dividend Growth model, Walter's model, MM dividend Irrelevance Model, Practice in Industry.

WORKING CAPITAL MANAGEMENT (9)

Current asset and liability decisions, estimation of working capital requirements, cash and marketable securities, Management of accounts receivables, financial aspects of investment, spontaneous financing, short term borrowings

COST ACCOUNTING (9)

Meaning and objectives, Classification, Elements of cost Accounting, Elements of costs, Preparation of cost sheet, Allocation and absorption of overheads, Budgetary Control - Types of budgets - Cash Budget, Functional Budgets, Flexible Budgets - Preparation and Interpretation

TOTAL: 45

References:

1. *Pandey, I.M, "**Financial Management**", Vikas Publishing House Pvt. Ltd., 8th Edition, 1999.*

2. *Prasanna Chandra, "**Financial Management**", Theory and Practice, Tata McGraw-Hill Publishing Company Ltd, 5th Edition, 2001.*

3. *James C Vanhorne, "**Financial Management and Policy"**, Pearson Education Asia (Low priced edition) 12th edition 2002.*

4. *Khan and Jain, "**Basic Financial Management and Practice**", Tata McGraw Hill – 5th Edition 2001.*

5. *S.K Bhattacharyya., John Dearden., "**Costing for Management**", Vikas Publishing 2002*

6. *Khan MY., Jain P.K., "**Management Accounting : Text, Problems and Cases**", 4th Edition, Tata McGraw Hill 2007*