COURSE STRUCTURE AND CURRICULUM

for

M.Tech Course

in

MANUFACTURING TECHNOLOGY

(Approved by AICTE & Affiliated to the West Bengal University of Technology, Kolkata)

National Institute of Technical Teachers' Training and Research, Kolkata

Block-FC, Sector-III, Salt Lake City
Kolkata-700 106

Revised March, 2010

CURRICULUM STRUCUTRE

First Semester

A.THEORY							
SL. NO.	**CODE**	**SUBJECTS**	**CONTACTS (PERIOD / WEEK)**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1.	MM (ME)101	Advanced Engineering Mathematics	3	1	-	4	4
2.	MTI 101	Industrial Management	4	-	-	4	4
3.	MTI 102	Metal Forming ,Casting & Welding	4	-	-	4	4
4.	MTI 103	Machining Science and Machine Tools	4	-	-	4	4
5.		Elective-I	4	-	-	4	4
		Total of Theory	19	1		20	20

B.LABORATORY / PRACTICAL							
SL. NO.	**CODE**	**SUBJECTS**	**CONTACTS (PERIOD / WEEK)**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1.	MTI 191	Manufacturing Technology Lab	-	-	4	4	2
2.	MTI 192	Machine Tools and Control Lab	-	-	4	4	2
3.	MTI 181	Seminar –I		2	-	2	1
		Total of Laboratory / Practical				10	5
		Total of Semester				30	25

Elective I: One subject to be chosen, from the following elective group.

CODE	SUBJECTS
MTI 104	Fabrication Technology
MTI 105	Fluid Drives and Controls
MTI 106	Industrial Robotics

Second Semester

A.THEORY							
SL. NO.	**CODE**	**SUBJECTS**	**CONTACTS (PERIOD / WEEK)**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1.	MTI 201	Quality & Reliability Engineering	4	-	-	4	4
2.	MTI 202	Automated Manufacturing System	4	-	-	4	4
3.	MTI 203	Modern Manufacturing Processes	4	-	-	4	4
4.		Elective –II	4	-	-	4	4
5.		Elective-III	4	-	-	4	4
		Total of Theory				20	20

B.LABORATORY / PRACTICAL							
SL. NO.	**CODE**	**SUBJECTS**	**CONTACTS (PERIOD / WEEK)**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1.	MTI 281	Seminar –II		2	-	2	1
2.	MTI 291	Flexible Manufacturing System Lab & Robotics Lab		-	4	4	2
3.	MTI 282	Comprehensive Exam (Viva-Voce)			-	-	4
		Total of Laboratory / Practical				6	7
		Total of Semester				26	27

Elective: One subject to be chosen from each of the following two elective groups

Elective – II

CODE	SUBJECTS
MTI 204	CAD/CAM
MTI 205	Computer Control of Machines and Processes
MTI 206	Finite Element Methods in Engg.

Elective – III

CODE	SUBJECTS
MTI 207	Product Design
MTI 208	Materials Handling System
MTI 209	Quantitative Decision Making

Third Semester

A.THEORY							
SL. NO.	**CODE**	**SUBJECTS**	**CONTACTS (PERIOD / WEEK)**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1.	MTI 381	Pre-submission Defense of Dissertation	-	-	-	-	4
2.	MTI 382	Dissertation (Progress)	-	-	-	24	18
		Total of Semester				24	22

Fourth Semester

A.THEORY							
SL. NO.	**CODE**	**SUBJECTS**	**CONTACTS (PERIOD / WEEK)**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1.	MTI 481	Dissertation (Completion)	-	-	-	24	18
2.	MTI 482	Post Submission Defense of Dissertation	-	-	-	-	6
		Total of Semester				24	24

ADVANCED ENGINEERING MATHEMATICS
(Code: MM (ME) 101)

Total Contact Hrs : 52	**Internal Assessment – 30**
Lecture : 39	**Examination – 70**
Tutorial : 13	**Total Marks: 100**

Statistics: Elements of statistics; frequency distribution; Concept of mean, median, mode and different types of distribution; Standard deviation and variance; Curve fitting by least square method; Correlation and Regression; Testing of hypothesis; Basic types of factorial design and Analysis of Variance. **-10**

Matrix Operation: Matrix operation; Eigen value and Eigen Vector by iterative methods; Diagonalisation of a square matrix. **-8**

Laplace Transform, Fourier Transform; Fourier Integral and their Applications; **-6**

Numerical Methods: Interpolation by Polynomials; Error Analysis; Solution of System of linear equation by Gauss-Seidel iterative method; Newton Rapson method; Numerical Integration by Gauss-quadrature; Solution of ordinary differential equation by Rayleigh-Ritz method. **-10**

Ordinary Differential Equation: i) 2^{nd} Order homogeneous Equation ii) Euler Cauchy Equation, iii) Non homogenous linear equation. **Partial Differential Equation :** i) Wave equation – one dimension and two dimension, ii) Heat equation – one dimension and two dimension **-5**

BOOKS:

1. S.S. Sastry- *"Introductory Methods of Numerical Analysis"*, PHI

2. M.K.Jain, S.R.K. lyengar, R., K.Jain; - *"Numerical Methods for Scientific and Engineering Computation"* New Age International Pub.

3. A.M. Goon, M.K.Gupta, B.Dasgupta; - *"An Outline of Statistical Theory" Volume I, II,* The World Press Private Ltd.

4. Yu.P.Adler, E.V. Markova, Ylu V. Granovsky; -*"The Design of Experiments to find Optimal Conditions"*, MIR, 1975, Moscow

5. Erwin Kreyszig - *Advanced Engineering Mathematics*, John Wiley & Sons, Inc

6. Stanley Grossman and William R.Derrick- *Advanced Engineering Mathematics*-.,Harper & Row Publishers

INDUSTRIAL MANAGEMENT
(Code: MTI 101)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Classification and Importance of Operations Management: 3

Operations Management in corporate profitability and competitiveness; Operations strategy; Types and characteristics of manufacturing systems and service systems;

2. Operations Planning and Control: 25

Forecasting for operations; Inventory planning and control; Materials requirement planning; Planning production in aggregate terms; Operations scheduling;

3. Quality Assurance: 8

The quality assurance system; choice of process and reliability; control of quality;

4. Maintenance Function: 4

Preventive maintenance; Overhaul and replacement.

5. Management Information System: 5

Need and structure of MIS; Data Processing Systems; Data Sources and Management

6. Human Resource Management 7

Concept and evolution; Manpower planning; recruitment and selection; Motivating personnel; Leadership;

REFERENCE

1. Buffa and Sarin – *Modern Production / Operations Management,* 8th ed., John Wiley & Sons (Asia) Pvt. Ltd.
2. Russell & Taylor – *Operations Management*, Wiley India Pvt. Ltd.
3. Larry Long –*Management Information Systems*, Prentice Hall
4. A.Leon– *Enterprise Resource Planning*, TMH
5. Gupta, C.B. – *Human Resource Management*, Sultan Chand & Sons

METAL FORMING, CASTING & WELDING
(Code: MTI 102)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Theory of Plasticity: 5

Theory of Plastic deformation, Yield criteria, Work of plastic deformation , Theories of Fracture, Ansiotropy in sheet metal, Overview of FEM Applications in Metal Forming Analysis - Formability studies.

2. Theory and Practice of Bulk Forming Processes: 10

Analysis of Plastic deformation in Forging, Rolling, Extrusion and rod/wire drawing processes-Effects of friction, Calculation of forces, Work done-process parameters, equipment used -Defects-Applications-Recent advances in forging, Rolling, Extrusion and drawing processes-Experimental techniques of evaluation of friction in metal forming, ring compression and double cup extrusion tests.

3. Sheet Metal Forming: 15

Conventional processes, Forces in circular cup drawing, Redrawing, drawing of tubes from annular sheet dies, Forming limit diagram, Forming with hydrostatic pressure, Explosive forming, electrohydraulic forming, magnetic pulse forming, Principles and process parameters- Advantages -Limitations and Applications.

4. Casting Metallurgy and Design 10

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

5. Special Casting Processes: 5

Shell moulding, Precision investment casting, centrifugal casting, Die casting and Continuous casting.

6. Advanced Welding Processes 7

Physics of welding arc, heat flow in welding, theory of heat flow, cooling rate determination, selection of welding parameters based of heat flow analysis, residual stress and distortion, joint design, analysis of fracture and fatigue of welded joints.
High energy density processes- Plasma keyhole welding, laser welding
Welding automation and robotics, advances in welding automation.

BOOKS:

1. Schuler - *Metal Forming Handbook* - Springer Verlag Publication
2. Hosford,WF and Caddell,R.M. - *Metal Forming:Mechanics and Metallurgy ,* Prentice Hall, Eaglewood Cliffs,1993
3. Dieter,G.E. - *Mechanical Metallurgy(Revised Edition II)* - McGraw Hill Co,1980
4. Altan .T.- *Metal Forming-Fundamentals and applications-American Society of Metals* , Metals park,1983.
5. Shiro Kobayashi, SOO-IK-oh-ALTAN,T - *Metal Forming and Finite Element Method* , Oxford University Press,
6. *ASM Metals of Hand book on Casting* - Revised Edn,1995
7. Heine loper & rosenthal,*Principels of Metal Casting ,* Tata McGraw Hill,1980
8. P.N.Rao- *Manufacturing Technology (Foundry,Forming and Wekding)II Edition",*Tata McGraw Hill Pub.Co. Ltd,.New Delhi,1998.
9. V.M. Radha Krishnan- *Welding Technology & Design* – New Age International Publishers
10. J.Norish- *Advanced Welding Processes*- Woodhead Publishing Limited

MACHINING SCIENCE & MACHINE TOOLS
(Code: MTI 103)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Geometry of Cutting Tools: **6**

Turning tools interrelations between different systems of rake angles; interrelationships between clearance angles; Milling cutters; Twist drills; Grinding of single point cutting tools.

2. Mechanism of Chip Formation: **5**

Observation methods; Chip formation analysis; Dynamic shear strain; Criticism of single shear plane theory; Effect of cutting variables on chip reduction coefficient; Different types of chips; Chip curl and cross section.

3. Force in Machining: **4**

Merchant's circle diagram for analysis of forces; Velocity relationships; Kronenberg's relationship; Dynamometry.

4. Heat in Metal cutting: **2**

Heat sources; Measurement of cutting temperature.

5. Machinability & Machining Economics: **5**

Machinability and machining efficiency; Machining economics.

6. Cutting Tool Materials: **4**

Failure of cutting tools; Essential properties of cutting tools; Development of tool materials- carbide, HPC, CBN, diamond.

7. Micro Finishing Processes: **3**

8. Transmission of Motions in Machine Tools: **6**

Classes of machine tool motions; Mechanisms; Kinematics structures; Differential mechanisms.

9. Spindle Drive: **5**

Spindle speed range; Layout of spindle speeds in AP and GP; Saw diagrams; Productivity analysis.

10. Machine Tool Gear Boxes: **4**

Number of steps & stages; Types of gear boxes; Rules for sliding cluster gear boxes; Speed structure and ray diagram; Calculation of gear teeth in a group transmission.

11. Machine Tools Strength & Rigidity: **3**

Principles of design for strength & rigidity; Evaluation of materials by weight; Compliance of machine tools.

12. Machine Tools Automation (Mechanical Control): **5**

Basic concepts and operating cycles of automatic machine tools (AMT); cam controlled AMT; Hydraulically operated and controlled AMT, Hydraulic Servosystems; Electromechanical Controls.

BOOKS:

1. Milton C. Shaw- *Metal Cutting Principles* , Oxford University Press
2. N.K.Meheta - *Machine Tools Design*, Tata McGraw -Hill Publishing
3. G.Kuppuswamy - *Principles of Metal Cutting,* Universities Press
4. S.K.Basu&D.K. Pal- *Design of Machine Tools* Oxford & IBH Publishing Co.
5. Edited by N.Acherkan- *Machine Tool Design : 4 vols.* , Mir Publishers, Moscow
6. A.Bhattacharya- *Metal Cutting Theory and Practice*, New Central Book Agency (P) Ltd.

FABRICATION TECHNOLOGY
(Code: MTI 104)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction to Fabrication **2**

2. Properties of materials, shapes and standard in metal fabrication. **4**

3. Metal cutting methods **10**

Shearing, punching, nibbling, sawing, flame cutting, piercing.

4. Metal forming **10**

Sheet metal forming, bending, forging, extrusion, drawing, rolling, spinning, pressworking.

5. Joining processes **10**

Bolting, riveting, welding – fusion and solid state welding, adhesive bonding, mechanical fastening, soldering, brazing.

6. Surface treatments, micro electronic fabrication **3**

7. Inspection and quality assurance **5**

8. Composite materials in fabrication **4**

Classification of composites, thermosetting, resin used for composites, composite reinforcement, processing of composites, joining of composites.

9. Automation in Fabrication **4**

BOOKS:

1. Kenyon Pitman- *Basic Fabrication & Welding*, Pitman Pub. Ltd.
2. F.J.M. Smith- *Basic Fabrication & Welding,* Longman Group Ltd.
3. Hazra & Choudhuri- *Workshop Technology Vol. 1 & 2,* Media Promoters & Publications
4. O.P. Khanna- *Welding Technology,* Dhanpat Rai & Sons
5. P.N.Rao- *Manufacturing Technology,* Tata McGraw Hill
6. DE Garmo et al- *Materials & Processes in Manufacturing* – Wiley

FLUID DRIVES AND CONTROL
(Code: MTI 105)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction to fluid power **1**

2. Classification of fluid power **1**

3. Energy and power in Hydraulic Systems **2**

Application of Pascal's law, Conservation of energy, the continuity equation, hydraulic horse power, Bernonll's equation, energy, power and flow rate in the SI Metric System.

4. The source of hydraulic power: Pumps **6**

Pumping theory, pump classification – Gear, vane, piston, pump performance, pump noise, pump selection.

5. Linear Actuator (Hydraulic Cylinder) **4**

Overall operating features, cylinder mountings and mechanical linkages, cylinder force, velocity and power, cylinder cushions, mechanics of hydraulic cylinder loadings, telescopic cylinder, design aspects.

6. Rotary Actuator (Hydraulic Motor) **2**

Classification: Gear, Vane, Piston; hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.

7. Valves and other control components in hydraulic systems **5**

Direction control valves, pressure control valves, flow control valves, cartridge valves, pressure and temperature switches, hydraulic accumulators, pressure intensifiers, servo valves.

8. Hydraulic Conductors and Fittings **2**

Conductor sizing, pressure ratings of conductors, steel pipes, steel tubing, plastic tubing, flexible hoses, quick disconnect couplings, metric size tubing.

9. Hydraulic Circuit Design and Analysis **9**

Control of a single acting hydraulic cylinder, control of a double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, pressure intensifier circuit, sequencing circuit, cylinder synchronization circuit, fail-safe circuit, speed control of hydraulic cylinder and hydraulic motor, hydrostatic transmission systems, analysis of hydraulic system with fictional losses, accumulator circuits.

10. Components of Pneumatic Systems **5**

Properties of air, the perfect gas laws, compressors, fluid conditioners, air control valves, pneumatic actuators.

11. Pneumatics: Circuit and Applications **5**

Pneumatic circuit design considerations, air pressure losses in pipelines, simple multicylinder circuits, emergency stop circuits, emergency stop circuits, fail-safe circuits, two-handed control, cascade circuits, cascade circuit design procedure, group selection and stepper circuits.

12. Electrical Controls for Fluid Power Circuits **7**

Electrical components, limit switches, solenoids, control of a cylinder using a single limit switch, reciprocation of a cylinder using pressure or limit switches, dual cylinder sequencing circuits, electrical control of a regenerative circuit, electro hydraulic servo system, application of Programmable Logic Controller (PLCs) in fluid power circuits.

13. Introduction to Fluidics **3**

Principles of fluids logic control, basic fluidic devices, fluid sensors, fluidic control of fluid power systems.

BOOKS:

1. Authony Esposito- *Fluid power with applications,* Prentice Hall International , Inc
2. S.R. Majumdar- *Oil Hydraulics,* Tata Mc Graw Hill
3. S.R. Majumdar- *Pneumatic System: Principles and Maintenance,* Tata Mc Graw Hill
4. D.D. Banks, D.S.Banks- *Industrial Hydraulics,* Prentice Hall
5. A.B.Goodwin- *Power Hydraulics,* B.I. Publications
6. Chris Stacey- *Practical Pneumatics*, Arnold Publications

INDUSTRIAL ROBOTICS
(Code: MTI 106)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction: **6**

History of robotics; Definition of robot; Main components of robot: manipulator, sensors, controller, power conversion unit; Robot geometry: types of joints, workspace, number of degrees of freedom; Common configurations used in arms: rectangular, cylindrical, spherical, jointed; Classification of robots according to coordinate system: Cartesian, cylindrical polar, articulated or jointed; Classification of robots according to control method: non-servo, servo; Robot specifications: payload, accuracy, repeatability, resolution, maximum tip speed, reach, stroke;

2. Robot End Effector **5**

End effector: definition, gripper, tools; Gripper : main parts, source of power; Types of grippers: mechanical grippers, vacuum cups, magnetic grippers, adhesive grippers, hooks , scoops, ladles; Universal gripper; Robot Tools: spot welding gun, pneumatic impact wrench, pneumatic nut runner, stud-welding head, inert gas welding torch, heating torch, grinder, spray painting gun.

3.Robot Actuators: **5**

Definition, Characteristics: power to weight ratio, stiffness, compliance, reduction gears; Conventional actuators: hydraulic actuator, pneumatic actuator, electric motor, direct drive motor, stepper motor; servo motor, Special actuators: magnetostrictive, shape memory, alloy, elestomer, Mc Kibben artificial muscle;

4.Robot Sensors: **7**

Definition of Sensor and transducer; Calibration; Basic categories of measuring devices: analog, discrete; Main types of sensors: position, velocity, acceleration, force and pressure, torque, touch and tactile, proximity, sniff, vision, voice recognition.

5.Robot Vision: **6**

Definition of digital image, generation of digital image; Robot Vision System: definition, use, functions, components, classification, vision cameras; Techniques of image processing and analysis: Image data reduction, segmentation, feature extraction, object recognition; Application of robot vision system.

6. Robot Kinematics: **9**

Definition of Robot kinematics, Tool frame and base frame. World –coordinate system, Direct kinematics, Inverse kinematics, Describing position and generation of a point in space, Derivation of rotational matrix by different methods, Homogenous transformation, Denavit- Hertenberg representation.

7. Robot Programming **5**

Definition of robot programming; Different methods of robot programming: teach-pendant programming, key board programming; Programming languages: VALII, AML/2, ARM BASIC

8. Industrial Application of Robots **6**

Material Transfer; Machine loading and unloading, Processing operations, Assembly operations, Inspection.

9. Economic Justification of Robots **3**

Advantages of applying robots in workspace, Methods of economic justifications for installing a robot: return on investment payback period, equivalent uniform annual cost method, annual cost method; Selection of a robot.

BOOKS:

1. Klafter, Richard D. Chmielewaski, Thomas A. and Negin, Michael (2001) - *Robotic Engineering*, Prentice-Hall of India Pvt. Limited.
2. Groover, Mikell P. Weiss, Mitchell., Nagel, Roger N., Odrey, Nicholas G.(1986) - *Industrial Robotics : Technology, Programming and Applications*, McGraw-Hill International Edition
3. Niku, Saeed B. (2001)- *Introduction to Robotics Analysis, Systems, Applications*, Prentice Hall of India Private Limited, New Delhi
4. Shilling , Robert J. (1990)- *Fundamentals of Robotics : Analysis & Control*, Prentice Hall of India, New Delhi
5. Koren, Yoram (1987)- *Robotics for Engineers*, McGrew-Hill Book Company, Sinagapore
6. Hall, Ernest L. Hall Bettie C. (1985)- *Robotics: A User-Friendly Introduction*, Holt, Rinehart and Winston, Holt-Saunders, Japan
7. Yoshikawa, Tsuneo (1990) *Foundations of Robotics : Analysis and Control*, Prentice Hall of India Private Limited, New Delhi
8. Mason, Matthew T. (2005), *Mechanics of Robotic Manipulation*, Prentice Hall of India Private Limited, New Delhi

QUALITY AND RELAIBILITY ENGINEERING
(Code: MTI 201)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1.Introduction: 3

Evolution of quality control; Quality: Definitions of quality, dimensions of quality of a product, dimensions of quality for service variables, attributes, defect, standard or specification, quality of design, quality of conformance, quality of performance; Quality Control: off-line quality control, statistical process controls, acceptance sampling plan; quality assurance, quality circles, quality improvement.

2. Total Quality Management: 7

Main themes of TQM: customer, process, people; Features of TQM model; Vision and Quality policy; Performance standards; Six sigma quality, Quality function deployment; Benchmarking; Quality auditing; vender selection and certification; Different TQM practices; ISO 9000, Malcolm Baldridge National Quality Award, International Quality Study; leading sages and Quality and their philosophy; W.Edwards Deming, Joseph M. Juran, Kaoru Ishikawa, Taguchi, Philip Crosby, Armand Feigenbaums;

3. Measures of Quality Product and Quality Process 3

Definitions and use of cost of quality, traditional cost of quality, cost elements of cost of quality: prevention cost, appraisal cost, internal failure cost, external failure cost, cost of quality report, limitations of cost of quality, emerging cost of quality model, uses of quality cost information, intangible cost.

4.Continual Improvement: Basic Tools 5

Kaizen, continuous improvement, continual improvement, types of data, population, sample, data summarization, methods of data summarization; tally sheet, frequency distributions, histogram, stem-and-leaf display, bar chart, Pareto chart, Pareto diagram, line graph or run chart, flow chart, cause-and-effect diagram, check sheet, box-plots, scatter diagrams or scatter plots, seven step method for continuous improvement, PDCA cycle.

5.Continual Improvement: Statistical Process Control **8**

Seven basic statement tools, different types of variation in the process outputs, definition of control chart, distinction between attributes and variables, control charts for attributes; p-charts, np-charts, c-charts, u charts; control charts for variables.
X-bar chart, R chart, individual chart; out-of control patterns; descriptive statistics and inferential statistics, Probability distribution, random variable, variance and standard deviation, normal distribution, behaviour of samples, Central Limit Theorem.

6.Continual Improvement: Some Advanced Tools **3**

Different approaches for problem solving adopted by management, brainstorming: traditional, electronic; Affinity diagram; Process capability: Relative Precision Index, Process Potential Index;
Six Sigma Quality, Taguchi methods: Total loss function, design of experiments, reduction in variation, statistically planned experiments.

7. Defining Reliability **4**

Reliability, demand time, one shot items, repeated cycles, time dependent items of specified mission continuously operating items, items in standby.

Basic statistics – The Binomial distribution, the Poisson distribution, the Exponential distribution, the log normal distribution, the weibull distribution.

8. Reliability Parameters **3**

Reliability as a function of time, failure rate as a function of time, constant failure rate, mission reliability, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failures (MTBF), mean down time (MDT), availability, complex system, increasing failure rate, Bath tub curve.

9. Reliability Predictions **3**

Condition for the prediction, cycle dependent performance, confidence estimates for success probability, confidence estimates for MTBF & constant failure rate, MTBF estimates, failure rate estimates, effects of environment and stress – accelerated testing.

10. Evaluating Data for Failure Rate Estimation **3**

Reliability versus operating time, failure density function versus operating time, failure rate versons operating time, Goodness-of-Fit Tests.

11. Reliability Modeling for System Predictions **3**

Systems series and parallel systems, duty cycling, redundancy: K-out-of N redundancy, standby redundancy.

12. Reliability – Modeling of Complex Systems **2**

The Markov Model Approach to solve complex system MTBF.

13. Risk Assessment **2**

Failure Modes and Effects Analysis (FMEA), Failure Modes Effects and Critically Analysis (FMECA), Fault Free Analysis (FTA), Petrinet modeling.

14. Reliability in Engineering Design **2**

Design synthesis, strength load interaction, reliability of the system, design based on reliability terotechnology and trends in design.

15. Maintenance Aspects **3**

Types of maintenance, preventive maintenance, spare parts management, use of Material Requirements Planning (MRP) approach for maintenance resources planning and control.

BOOKS:

1. Paul Kales - *Reliability for Technology, Engineering and Management.* – Prentice Hall
2. Bikas Bhadury & S.K.Basu - *Terotechnology : Reliability Engineering and Maintenance Management* – Asian Books Private Limited
3. E. Balguruswamy - *Reliability Engineering* – Tata McGraw Hill Publishing Co-Limited.
4. Amitava Mitra -*Fundamentals of Quality Control and Improvement* – Prentice Hall of India Pvt. Ltd., New Delhi
5. Jill A.Swift, Joel E. Ross and Vincent K.Omachonu -*Principles of Total Quality* – St. Lucie Press Boca
6. William J. Kolarik - *Creating Quality : Concept, Systems, Strategies and Tools* – McGraw-Hill Inc.
7. Donna C.S.Summers - *Quality*– Prentice Hall, International Inc, New Jersey
8. Douglas C.Montgomery- *Introduction to Statistical Quality Control* – John Wiley & Sons Incs, New York
9. Bertrand L.Hansen and Prabhakar M.Ghare - *Quality Control and Application* – Prentice Hall of India Pvt. Ltd., New Delhi
10. Samuel K.Ho - *TQM: An Integrated Approach* – Kogen page India Pvt. Ltd., New Delhi
11. D.J.Smith-*Reliability Engineering* – Pitman
12. L.S.Srinath- Reliability Engineering– East West Press

AUTOMATED MANUFACTURING SYSTEM (AMS)
(Code: MTI 202)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction **2**

Developments in manufacturing technology in automation, A hierarchical model of factory automation, Systems requirements and automatic control technology, Classification of NC systems

2. Features of numerically controlled machines **4**

Fundamentals of machining, Design considerations of NC machine tools, Methods of improving machine accuracy, Increasing productivity with NC machines, Machining centers, CNC controllers.

3. Fundamentals of NC part programming **6**

Preparatory functions, Axis motion commands, Feed and speed commands, Miscellaneous command, , Conventional numerical control, Direct numerical control, Computer numerical control, Computer aided part programming, APT language basics, CAD/CAM based part programming

4. Manufacturing Planning and Control Systems **5**

A basic framework for manufacturing and planning, Demand management, Aggregate production planning, Master production schedule, Material requirement planning, MRP lot sizing problem, Capacity planning, Shop floor control

5. Group Technology and Cellular Manufacturing Systems **12**

Concept of Group Technology, Design attributes and manufacturing features, GT implementations, Part family formation, Selection of classification and coding system, Benefits of group technology, Concept of cellular manufacturing, Cell formation approaches, Economics of group tooling in cellular manufacturing, Production planning and control in cellular manufacturing

6. Flexible Manufacturing Systems **17**

Concept of different types of flexibility, Volume variety relationship for understanding production systems, Key characteristics of various manufacturing systems, Concept of FMS, Basic features of physical components of FMS, Basic features of control components of an FMS, Operational problems in FMS, Layout considerations Sequencing of Robot moves in Robotic cell, FMS benefits

7. Enterprise Integration CIM, Future Trends **6**

Introduction to CIM, Network communication, Networks architecture and protocol, Database managements systems, Realizing CIM

BOOKS:

1. Thomas A. Boucher- *' Computer Automation in Manufacturing: An Introduction',* Chapman and Hall
2. Yoram Koren - *'Computer Control of Manufacturing Systems'*, Macgraw Hill Internationl Book Company
3. Nanua Singh - *'System Approach in Computer Iontegrated Design and Manufacturing'* , John Wiley and Sons, Inc.
4. Narahari and Viswanadham - *" Performance Modelling and Analysis of Automated Manufacturing systems "* Prentice Hall
5. James G.Bralla -*" Handbook of product design for manufacture "*, McGraw Hill Book co.,1986
6. Henry Peck, *" Designing for manufacture ",* Sir issac Pitman & Sons Ltd.,1973.
7. Matousek, *" Engineering Design ",* Blackie & Sons,1956.

MODERN MANUFACTURING PROCESSES
(Code: MTI 203)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction **2**

Various modern manufacturing processes.

2. Mechanical Machining Processes **12**

Abrasive Jet Machining (AJM), Ultrasonic Machining (USM), Abrasive Finishing Processes – Abrasive Flow Finishing (AFF), Magnetic Abrasive Finishing (MAF), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM).

3. Thermoelectric Machining Processes **15**

Electric Discharge Machining (EDM), Electric Discharge Grinding and Electric Discharge Diamond Grinding, Wire Electric Discharge Machining, Laser Beam Machining (LBM), Plasma Arc Machining (PAM), Electron Beam Machining (EBM).

4. Electrochemical and Chemical Manufacturing Processes **12**

Electrochemical Machining (ECM), Electromechanical Grinding (ECG), Electrochemical Drilling (ECD), Electrochemical Deburring (ECDe), Chemical Machining (ChM)

5. High Velocity Forming Processes **5**

Explosive forming processes, Propellant forming, Electro-Hydraulic forming, Electromagnetic forming, Pneumatic / Mechanical forming.

6. Micro-Machining, MEMS and Nanotechnology **6**

Classification of Micromachining, Various Micromachining Processes- Abrasive micro machining, Ultrasonic micro machining, Micro EDM, Micro ECM, Laser Micromachining.

MEMS (Micro Electro Mechanical Systems)- Development and need of MEMS, overview of MEMS technology with relevant non conventional processes.
Nano materials, Nano tubes and Nano wires, Nanofabrication.

BOOKS:

1. V.K.Jain – *Advanced Machining Processes ,* Allied Publishers Pvt. Limited, India
2. P.K.Misra - *Non-conventional Machining*, Narosa Publishers,
3. Pandey & Shan - *Modern Machining Processes*, Tata McGraw Hill
4. Mark Ratner, Daniel Ratner – *A general introduction to the Next Big Idea Nano technology* Pearson Education.
5. G.F.Benedict – *Non-traditional Machining Processes*, Marcel Dekker Inc.,
6. J.A.McGeough, *Advanced Methods of Machining,* Chapman and Hall
7. Amitava Ghosh & Ashok Kumar Mullick– *Manufacturing Science,* West Press PVt. Ltd.
8. Joseph McGeough – *Micromachining of Engineering Materials*, Marcel Dekker
9. Mikell P.Groover – *Fundamental of Modern Manufacturing: Materials, Processes and Syste*, Willey

CAD/CAM
(Code: MTI 204)

Total Contact Hrs: 52

Internal Assessment – 30
Examination – 70
Total Marks: 100

1. The design process and role of CAD **2**

The design process, Types of design model, Concurrent engineering, Modelling using CAD, A CAD system architecture

2. Techniques for geometric modeling **6**

Representations of curves, Parametric representation of geometry, Bezier curves etc., Techniques for surface modeling, Different types of patches, Techniques for volume modeling , boundary model, Constructive solid geometry etc.

3. Elements of interactive computer graphics **4**

Introduction to computer graphics, Computer graphics hardware, Two dimensional computer graphics, Vector generation, Clippng, Three dimensional computer graphics, Viewing transformation, Techniques for visual realism, Interaction with the syatem and the model.

4. Entity manipulation and the data storage **4**

Manipulation of the model, Introduction to data storage, Data structures for interactive modeling, Object oriented representations, Database considerations

5. Standards for CAD **2**

Graphics and computing standards, Graphics Kernel system, Standards for exchanging images, Data exchange standard, IGES and DXF standards, and Communication standards

6. The design/manufacture interface **16**

The limitations of traditional engineering approaches, Current theme in manufacturing engineering, Group technology, The design for manufacture and assembly, Overview of process planning techniques, The total approach for product development, The system approach, Concurrent engineering, The total quality approach, The techniques of quality engineering, Quality function deployment

7. Introduction to machine control **12**

Fundamentals to numerical control, Data preparation for numerical control, Machining for 3D model, Introduction to Rapid prototyping, Robotic Technology, Cellular manufacturing

8. Production planning and control **4**

Introduction too production planning and control, Requirement planning systems, Shop floor control system, Scheduling techniques, Just in time manufacturing

9. Future directions of CAD/CAM **2**

Product data management , Product modeling, Assembly and tolerance modeling etc.

BOOKS:

1. Chris McMohan & Jimmi Brown- *" CAD CAM ",* Addison,Wiley-2000.
2. Donatas tijunela & Kirth E- " Manufacturing High Tech Handbook ", Mckee-2000.
3. Narahari and Viswanadham-*"Performance Modelling and Analysis of Automated Manufacturing systems "*-Prentice Hall-1998.

COMPUTER CONTROL OF MACHINES AND PROCESSES
(Code: MTI 205)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction: **5**

Computer in process control, Hierarchical Control, Control Networks, Interfacing, Computer Communication : Transmission, Coding, Types of communication lines, communication hardware; Network Architecture: Open System Inter Connector (OSI), LAN, Manufacturing Automation Protocol (MAP), Databases in Control, Control Hierarchy, Control Computers, Discrete event system and supervisory controller software design : Petri net modeling, mathematical properties of ordinary Petri nets, software specification for a machining cell controller.

2. Numerical Control Machines : **9**

Type of CNC Machines: CNC plasma machines, CNC spring forming machines, CNC laser cutting machines, vertical machining centers, horizontal machining centers, variable axes machining control, CNC Press brakes, CNC Punch press; Point-to-point machines, continuous path machines; machines tool axes, components of CNC machines; NC / CNC controls, CRT displays, drive motors, stepping motors and open-loop systems, servo motors and closed loop system, CNC machine; axes and coordinate systems; absolute and incremental programming, word address programming, part programming, programming procedure, incremental positioning, circular interpolation, tool length offset, tool diameter offset.

3. Robot Technology : **10**

Definition of Robot; robot anatomy; joints and links, common robot configurations; Robot Control Systems; Drive Systems, Types of robot control; Accuracy and Repeatability; End Effectors; Sensors in Robotics; Types of Robot Programming: manual setup, lead through programming, robot programming languages, off-line programming.

4. Automated Material Handling: **7**

Material handling function; Types of material handling equipment; Analysis of Material handling Systems: consideration of material and movement conditions, material handling analysis techniques; Design of the System: effect of plant layout, principles of material handling; Conveyor Systems: types of conveyors, quantitative relationships and analysis of conveyor systems; Automated Guided Vehicle Systems (AGVS): types of AGVS, applications, vehicle guidance and routing, traffic control and safety, system management, quantitative analysis of AGV Systems.

5. Automated Storage Systems: 7

Storage System Performance : Types of materials stored in factory, storage capacity, system throughput, storage transactions, utilization, uptime reliability; Automated Storage / Retrieval Systems (AS/RS); Definition, important categories of automated storage /retrieval system, basic components of an AS /RS, AS/RS controls, special features, applications, quantitative analysis, caruosel storage systems: Configuration and control features, Coruosel storage application, Quantitative analysis; Work-in Process Storage : Interfacing handling and storage with manufacturing : types of interface, positional accuracy, methods of load transfer.

6. Computer Process Control: 8

Definition : Computer – process interface : characteristics of manufacturing process data, process data input / output; Interface hardware : sensors and transducers, analog-to-digital converters, digital-to-analog converters, multiplexers, pulse counters and pulse generators; Computer Process Monitoring, Types of computer process control: preplanned control, direct digital control, supervisory computer control; Programming for computer process control: requirements of control programming, interrupt system, error detection and recovery, diagnostics;

7. Sequence Control and Programmable Controllers: 6

Logic control and sequencing : logic control system, sequencing system; Logic control elements: logical AND, OR, and NOT gates, boolean algebra, hardware for implementing combinational systems; sequencing elements; Timers, Counters; Ladder Logic Diagrams; Programmable Logic Controllers (PLC): Components of PLC, Programming the PLC, How the PLC operates, Additional capabilities of PLC.

BOOKS:

1. Mikell P.Groover – *Automation, Production Systems and Computer – Integrated Manufacturing,* Prentice Hall of India Pvt. Ltd.
2. HMT Limited *Mechatronics,* Tata Mc Graw – Hill Publishing Company Ltd.
3. Jon Stenerson and Kelly Curran– *Computer Numerical Control : Operation and Programming* , Prentice Hall, New Jersey
4. S.Kant.Vajpayee- *Principles of computer – Integrated Manufacturing,* Prentice Hall of India.
5. Thomas O. Boucher- *Computer Automation in Manufacturing: An Introduction,* Chapman & Hall
6. David J.Williams- *Manufacturing Systems: An Introduction to the Technologies:* Halsted Press
7. James V.Valentino and Joseph Goldenberg (2000) – *Introduction to Computer Numerical Control* – Prentice Hall
8. G.E. Thyer (1988) – *Computer Numerical Control of Machine Tools*– Newnes, Butterworth-Heinemann Ltd., Oxford

FINITE ELEMENT METHOD IN ENGINEERING
(Code: MTI 206)

Total Contact Hrs: 52

Internal Assessment – 30
Examination – 70
Total Marks: 100

1. Introduction to Finite Element Procedures **3**

Introduction, Physical problems, Mathematical models, Finite element as a part of computer aided design.

2. Vectors, Matrices and Tensors. **4**

Introduction, vector spaces, Subspaces, Matrix representation linear transformation. The eigen-problem. The Rayliegh quotient and minimax, characterization of eigenvalues, vectors and matrix norms.

3. Engineering analysis with FEM. **7**

Steady state problem, propagation problems. Eigen problems differential formulation, variational problems, weighted residual method, rifz method, finite different differential and energy methods, introduction to language multipliers, and penalty method.

4. Formulation of Finite Element Method **12**

Introduction, Formulation of finite element method using the principle of virtual displacement transformation matrices for plane stress analysis, General formulation. Lumping of structure properties and loads. Requirement of monotonic convergence, finite element models.

5. Linear Analysis with FEM **11**

General deviation of finite element equilibrium equations, imposition of displacement boundary conditions. Generalized coordinate models for specific problems, Definition of convergence criteria for monotonic convergence, Incompatible displacement must based models, Mixed formulations. Mixed interpolohous, Incompressible analysis.

6. Non-linear analysis with FEM **10**

Introduction, Formulation of continuum machines incremental equation of motions the deformation, gradient, strain, and stress tensors, displacement / pressure formulation for large deformations, structural elements contact conditions.

7. Heat transfer, field problems and incompressible fluid flow. **5**

Governing heat transfer equations, finite element discretization of heat transfer equations. Analysis of field problems, analysis viscous incompressible fluid flows.

BOOKS:

1. Keneth H.Huebner, Donald L.Dewhirst, Doglas E.Smith, Ted. G.Pyrson- *The Finite Element Method for Engineers,* John Willey and Sons Inc.
2. J.N. Ready- *An Introduction to the Finite Element Methdo,* Mc Graw Hill Publishing Company, New York
3. K.J. Bathe, *Finite Element Procedure, Prentice Hall of India Publishing Company*

PRODUCT DESIGN
(Code: MTI 207)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction **2**

Definition: Product development Process, Product Design; Types of design, engineering design; phases of modern product development process; Reverse engineering and redesign product development process.

2. Product Development Process Tools and Scoping Product Developments **4**

Product development team: definition, composition, team roles, Myer-Briggs type indicator, team structure, team building, team evaluation; Product Development Planning: Steps of planning, basic planning and scheduling tools; S-curves: definition, s-curves and new product development, technology forecasting; Basic method: technical questioning, mission statement; Advanced method: Business case analysis, design drivers;

3. Customer Needs: **5**

Customer satisfaction: Kano diagram, customer populations, types of customer needs, customer need models; Customer needs gathering methods: interviews, questionnaires, focus groups, be the customer need models; Customer Need Gathering Methods: Interviews, questionnaires, focus graphs, be the customer. Grouping the needs: affinity diagram method, customer sort method; determining need importance; interview data method, questionnaire method; cluster analysis method;

4. Establishing Product Function Product Teardown and Experimentation: **8**

Functional Decomposition: product function, sub function, abstraction, constraints; Modeling process: Function Analysis System Technique (FAST), Subtract and Operate procedure; Function structure: phases modeling process; Function structure decomposition; Product Teardown: phases of product teardown process; teardown methods; measurement and experimentation; Post teardown reporting; application of product teardown.

5. Benchmarking and Establishing Engineering Specifications: **6**

Benchmarking: steps of benchmarking, support tools for benchmarking; Setting product specifications: Specification process, fundamental requirements and constraints, specifications sheets, House of Quality, value analysis

6. Product portfolios, Portfolio architecture and Product Architecture: 5

Product portfolio architecture: definition, types, choosing an architecture type;
Platform architecture: Modular family platform, functional architecting, steps of platform design method, functional architecting, non-platform based products, platform based products; Product architecture types: integral, modular; Product modularity: type of modularity, cluttering methods, advanced functional method, Architecture-based development teams.

7. Generating Concepts, Concept Selection and Concept Embodiment 5

Concept Generating Process: basic methods, advanced methods, morphological analysis, combining solution principles; Estimating Technical Feasibility, Concept Selection Process, Pugh Concept Selection Chart, Measurement theory, Numerical Concept Scoring; Refining geometry and layout, Systems modeling.

8. Modeling of Product Metrics 3

Model selection by performance specifications, Mathematical modeling, physical prototyping, constructing product models.

9. Design for Manufacture and Environment Assembly 1

Design guidelines, Manufacturing cost Analysis.

10. Design for Environment 2

Environment objectives, Basic design for environmental methods, life cycle assessment, techniques to reduce environmental impacts.

11. Analytical and Numerical Model Solutions 4

Solution definition, Pareto optimality, Spreadsheet search, concept of optimization, Analytical formulations, practical optimization.

12. Physical Prototypes Physical Models and Experimentation 4

Physical models, Prototypes, Types of prototypes, uses of prototypes. Rapid prototyping techniques, Scale, Dimensional analysis, Similitude, Physical prototype design and planning. Design of experiments, Reduced tests, Fractional experiments, Statistical analysis of experiments.

13. Design for Robustness: 3

Quality design theory, Taguchi's method.

BOOKS:

1. Kevin N. Otto and Kristin L.Wood 2001) – *Product Design*, Research Education, Delhi
2. Harry Cather, Richard Morris, Mathew Philip, Chris Rose (2001)– *Design Engineering,* Butterworth Heinemann
3. Nigel Cross– *Engineering Design Methods: Strategies for Product Design*– John Wiley & Sons Ltd., England
4. M.A. Parameswaran– *An Introduction to Design Engineering*– Alpha Science International Ltd., Harrow, U.K.
5. M.A. Annachino – *New Product Development*– Butterworth-Heinemann
6. Anil Mital, Anoop Desai, Anand Subramanium, Aashi Mital– *Product Development: A Structured Approach to Consumer Product Development, Design and Manufacture* – Butterworth-Heinemann
7. George E.Dieter and Linda C.Schmidt – *Engineering Design* – McGraw–Hill International Edition

MATERIALS HANDLING SYSTEM
(Code: MTI 208)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1. Introduction to Materials Handling: 4

Definition, scope and importance of Materials Handling; System concept; Classification and characteristics of materials.

2. Principles of Materials Handling : 3

Significance of Materials handling principles; Different principles and suggestions for their application.

3. Unit Load Concept: 3

Advantages and disadvantages; Load unitization processes; Pallets, skids & containers; Packaging for Materials Handling.

4. Classification of Materials Handling Equipment: 1

5. Industrial Vehicles / Trucks: 6

Hand trucks; Power trucks; Forklift trucks and attachments.

6. Conveyors: 12

Belt Conveyors – characteristics, types, components, basic design considerations; Chain Conveyors – characteristics, types, components, aspects of design; Roller Conveyors-characteristics, types, components, aspect of design; Screw conveyors – characteristics, types, components, aspects of design.

7. Pneumatic & Hydraulic Conveyors: 4

8. Hoisting Equipment: 12

Hoists; Winches; Elevators – types and parts of hoisting equipment, design considerations, Cranes : wharf cranes, level buffing system, Derricks.

9. Robotic Handling : 2

Materials handling at workplace; Types of robots; Robotic handling applications; AGV.

10. Auxiliary Equipment: **3**

Gates; Feeders; chutes; Positioners; Weighing and control equipment.

11. Organisation, Maintenance & Safety: **2**

BOOKS:

1. Apple, J.M - *Material Handling System Design,* John Wiley & Sons
2. Allegri,T.H. *Materials Handling: Principles and Practice,* CBS Publishers & Distributors, N.Delhi
3. Immer- *Materials Handling* , J.R, McGraw Hills
4. Spivakovsky,A and Dyachkov,V- *Conveyors and Related Equipment*, Peace Publishers, Moscow
5. Rudenko N.- *Materials Handling Equipment,* Peace Publishers, Moscow
6. Alexandrov,M.P- *Materials Handling Equipment, Part-I and II,* Mir Publishers, Moscow
7. Ray, T.K.- *Mechanical Handling of Materials,* Asian Books Private Ltd., 2004
8. Ray, S.- *Introduction to Materials Handling,* New Age International Publishers, 2008.

QUANTITATIVE DECISION MAKING
(Code: MTI 209)

Total Contact Hrs: 52 **Internal Assessment – 30**
Examination – 70
Total Marks: 100

1.Introduction to Operations Research: 2

2. Linear Programming (LP): 10

Introduction; Problem formulations; Mathematics of LP; Simplex procedure; Sensitivity analysis; Computer implementation.

3.Transportation and Assignment Problem: 7

4.Network Analysis: 4

Shortest-route problem; The minimum spanning tree problem; The maximal flow problem.

5. Project Scheduling : 7

Critical path method (CPM); Network construction and determination of critical path; Crashing; Resource smoothing.

6. Non-Linear Programming : 10

Graphical illustrations; Unconstrained optimization-direct search method and steepest descent method; Constrained optimization by lagrange multipliers; Integer linear programming by Branch &Bound technique.

7. Metaheuristics 8

Tabu search, Genetic algorithm.

8. Forecasting Techniques : 4

BOOKS:

1. F.S.Hillier, G.J.Lieberman– *Introduction to Operations Research*; The McGraw Hill Companies
2. R.L.Ackoff, M.W.Sasieni; *Fundamental of Operations Research*, John Wilkey & Sons, Inc.
3. Anderson, Sweeney- *An Introduction to Management Science*, Williams; West Publishing Co.
4. I.A.Taha *Operations Research : An Introduction,* Prentice Hall of India.
5. C.K.Mustafi- *Operations Research*, New Age International Publishers
6. S.S.Rao- *Engineering Optimization*, New Age International Publishers