# MMIP/MMCM – 401 Rapid Prototyping and Rapid Tooling

**Unit -I**

Product Development Cycle, Phases of Product Development, Problems in Product Development. Need for Rapid product development. Virtual Reality (VR), Introduction, Features use in VR, Technologies used in VR, Augmented reality. Virtual Manufacturing.

**Unit -II**

Rapid Prototyping. Methods of Rapid prototyping. CAD to Rapid prototyping Process, STL format, Support structures, Classification of RP methods. Laminated Object Manufacturing (LOM), Approaches to LOM, Steps in LOM, LOM machine and process capability, Applications, Kira's LOM. Fused Deposition Modeling (FDM), principles, steps, machines and applications. Selective Laser Sintering (SLS), Principles, Operations, Machines, Materials and Applications. 3D Printing. Principles, Operations, Machines, Materials and Applications

**Unit -III**

Selective Photocuring technologies: Selective Laser Scanning, Stereo Lithography Apparatus (SLA). Principle, Steps and post processing. SLA machines and process capability, Applications. Photocuring through Mask, Solid Ground Curing (SGC), Principle, Steps, Application and machines. SLA Quick CAST and its applications. ObJet machine, principle and operation. Prefactory RP machine.

**Unit -IV**

Emerging Techniques in RP: Shape Deposition Modeling, Contour Crafting, Droplet Deposition Method. Reverse Engineering, Approaches, CMM and its applications, Principle of Non-contact Measurement: Laser Scanner, Photogrammetry, 3D Reconstruction from Photographs, Industrial CT Scan, Principle of CT Scan, Magnetic Resonance Imaging, Principle of MRI, 3D Reconstruction.

**Unit -V**

Rapid Tooling: Indirect methods, Silicon Rubber Molding, Epoxy Tooling, Electroforming, Spray Metal Tooling, Cast Kirksite Tooling, 3D Keltool, Direct methods: 3D printing, SLS, Laminated Tooling, Hybrid Layer Manufacturing. Application of Rapid Tooling and their process capabilities.

**References**

1. Integrated Product Management, Andreasen MM, Hein L, IFS publication
2. Automated Fabrication: Burns
3. Peter D. Hilton and Paul F. Jacobs (Ed.), 2000, *Rapid Tooling: Technologies and Industrial Applications*, Marcel Dekker
4. Rapid Prototyping, Principles and Applications, 2nd Edition, C K Chua, K F Leong & C S Lim

# MMCM – 402(A) Research Methodology

**Objective:** This course will enable scholars to identify and apply appropriate research methodology in order to plan, conduct and evaluate basic research. The course will furthermore enable scholars to distinguish between the scientific method and common sense knowledge while laying the foundation for research skills at higher levels.

**1. Research :**

a)  Types, Research process and steps in it, Hypothesis, Research proposals and aspects. Research Methodology: Objectives of Research, Motivation in Research, Types of Research, Research Approaches, and Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem.

b)  **Research Design: Need, problem Definition, variables, research design concepts, Literature survey and review, Research design process, Errors in research.** Data Collection and Representation : Primary Data, Secondary Data, Data Presentation , Processing and Analysis of Data: Statistics in Research, Measures of Central Tendency , Measures of Dispersion (Variation), Measures of Asymmetry (Skewness), Measures of Relationship, Forecasting, Linear Regression and Time series.

c)  **Sampling Methods and Distributions:** Sampling Methods, Sampling Distribution of mean, Sampling Distributions of Variance.  Testing of Hypothesis-I:Basic Concepts Concerning  Testing of Hypotheses , Procedure for hypothesis Testing, Flow Diagram for Hypothesis Testing, Measuring the Power of a Hypothesis Test, Important Parametric Tests, Limitations of the tests of the Hypotheses , Chi-square Test, Non- Parametric Tests.

d)  **Research Modeling : Types of Models, Model building and stages, Data consideration and testing, Heuristic and simulation modeling,** Simulation : Need for simulation, Types of Simulation, Simulation languages

e)  **Report Writing: Pre writing considerations, Thesis writing, formats of report writing, Formats of publications in Research journals.** Technique of Interpretation, Precaution in Interpretation Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Report Format, Typing Instructions, Oral Presentation.

**2. Design of Experiments :**

a) Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles-replication, randomization, blocking, Guidelines for design of experiments.
b) Single Factor Experiment: Hypothesis testing, Analysis of Variance components (ANOVA) for fixed effect model: Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking.
c) Two factor factorial Design, Basic definitions and principles, main effect and interaction , response surface and contour plots, general arrangement for a two-factor factorial design; Models Effects, means and regression, Hypothesis testing.

**Reference books:**

1. C.R. Kothari, Research Methodology Methods and Techniques (Second Revised Edition), New Age International Publication.
2. R. Panneerselvam, , Research Methodology, PHI
3. Ranjit Kumar, Research Methodology: a step –by step guide for beginners, SAGE Publication Ltd.
4. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India)
5. Montgomery, Douglas C. & Runger, George  C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India)
6. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006) Management research methodology, Pearson Education.
7. Research Methodology; Integration of Principles, methods and Techniques (Person Education, New Delhi)

# MMCM – 402(B) Intelligent Manufacturing

**Unit-I**

Artificial & Natural Intelligence, Definition and Terminologies, Declarative programming, Production Systems, Heuristics, Problem Characteristics.

Search Techniques: Best first, Depth first & Breadth-first search, Branch and Bound, AND/OR graphs, Game Playing, General problem solver, Constraints satisfaction, Planning of tasks. Structured knowledge representation, knowledge representation issues, Predicate logic, Resolution, Representing knowledge using rules, Frame, Scripts, Conceptual dependency and Semantic nets. Application of knowledge based systems in design and manufacturing

**Unit-II**

Neural Computing, Structure and functioning of biological brain and neuron, concept of learning/training. Model of Artificial neuron, Transfer functions, ADALINE, Perceptron: Binary & Continuous inputs, linear seperability.

**Unit-III**

Multiplayer Perceptions: Significance, Training using Back Propagation Algorithm & its derivation, Problems with Back Propagation. Hop-field Nets: Architecture, Energy functions, Training algorithms and examples. Application of NN in design, manufacturing and management

**Unit-IV**

Expert Systems: Introduction, Concepts of ES, Characteristics of ES, The Development of ES Technology, Expert System applications and domain .Application of ES in Design, Manufacturing and Management

**Unit-V**

Fuzzy Systems: Fuzzy Set Theory, Fuzzy complement, Union and Intersection. Fuzzy Logic: AND, OR, NOT operations, DeMorgans Law, Membership functions, Fuzzy relations, Application of Fuzzy logic: Fuzzy control- selection of membership functions, Fuzzifications, Rule based design & Interfacing, defuzzification, Applications in Manufacturing and design

**Books & References Recommended :**
1. Kosko B. Neural Networks and Fuzzy Systems –PHI
2. Aleksander & Morton, An Introduction to Neural Computing
3. Elaine Rich, Kevin Knight- Artificial Intelligence
4 Schalkoff, Artificial Intelligence: An Engineers Approach, McGraw Hill
5. Yoh-Han Pao –Adaptive Pattern Recognition and Neural Networks Addison-Wesley

# MMCM 402(C) Reliability and total productive maintenance

**Unit 1** INTRODUCTION: Reliability function - MTBF - MTTF - mortality curve - availability - Maintainability.

**Unit 2** FAILURE DATA ANALYSIS: Repair time distributions - exponential, normal, log normal. gamma, and Weibull- reliability data requirements - Graphical evaluation.

**Unit 3** RELIABILITY PREDICTION: Failure rate estimates - Effect of environrl:1ent and stress - Series and Parallel systems - RDB analysis - Standby Systems - Complex Systems.

**Unit 4** RELIABILITY MANAGEMENT: Reliability demonstration testing - Reliability growth testing - Duane curve -Risk assessment - FMEA, Fault tree.

**Unit 5** TOTAL PRODUCTIVE MAINTENANCE: Causes of Machine Fialures - Downtime -Maintenance policies - Restorability predictions - Replacement models - Spares provisioning - Maintenance management - Cleanliness and House Keeping.

**Reference Books:**
1. Paul Kales, Reliability for technology, "En.",ineerin't'!; and Mana't'!;emefif ", Prentice Hall, New Jersey, 1998.
2. Modarres, "Reliability and Risk Analysis ", MeralDekkerlnc., 1993.
3. Gopalakrishnan.P, and Banerji A.K., " Maintenance and ,<;'pare Parts Management ", Prentice Hall of India, New Delhi, 1996.

# MMCM – 403(A) Robotics and Automated Material Handling

**Unit-I**

INTRODUCTION: Basic concepts - Robot anatomy - Robot configurations – Basic robot motions - Types of drives - Applications - Material handling - processing - Assembly and Inspection - safety considerations.

**Unit-II**

TRANSFORMATIONS AND KINEMATICS: Vector operations – Translational transformations and Rotational transformations - Properties of transformation matrices- Homogeneous transformations and Manipulator - Forward solution - Inverse solution.

**Unit-III**

CONTROLS AND END EFFECTORS AND SENSORY DEVICES: Control system concepts - nalysis - control of joints - Adaptive and optimal control - End effectors - Classification - Mechanical -Magnetic -Vacuum - Adhesive - Drive systems - Force analysis and Gripper design. Non optical and optical position sensors - Velocity and Acceleration -Range - Proximity - touch - Slip - Force - Torque - Machine vision – Image components -Representation - Hardware - Picture coding - Object recognition and categorization – Software consideration.
.

**Unit-IV**

ROBOT PROGRAMMING: Methods - Languages -Computer control and Robot Software -V AL system and Language. .

**Unit-V**

Automated Material Handling and Storage: Functions types and analysis of material handling equipment, Design of conveyor and AGV system, Storage system performance, AS/RS, Carousel storage system, WIP storage system, Interfacing handling, Storage with manufacturing

**Reference Books:**

1. Fu KS., GonzalezR.C.., and Lee C.S.G., "Robotics control, sensing, vision, and intelligence McGraw-Hill Book Co., 1987.
2. Klafter R.D., Chmielewski TA. and Negm IV. .. Rohot Engineering An Intergrated approach Prentice Hall of India, New Delhi, 1994
3. Deb S.R., " Robotics Technology and Fle.rihle Auto"w(i('fl ", Tata McGraw-Hill Publishing Co., Ltd.. 1994.
4. Craig J..J. " 1ntroduction to Robotic.s Mechanics and Control ". Addison-Wesley, 1999.

# MMCM – 403(B) Manufacturing Systems Engineering

### Unit-I

FMS: Basic System configuration, Flexibility analysis, Industrial Robotics and FMS communications, Software for FMS, FMS control systems & interfaces, Implementing FMS, Design and implementations aspects of FMS.

### Unit-II

CIM & Factory of Future: Design aspects of CIM, Nature & Categories of "Factory of the future", Manufacturing Cell, Design & Planning for futuristic factory, MAP/TOP.

### Unit-III

Automated Generation of CNC Programs: Integration of CAD/CAM, Methods of Pocket machining and surface machining, CAM software. Robot Programming using VAL, Robot Kinematics, Robot motion analysis and control intelligent robots, CAPM integrated production management.

### Unit-IV

Computer Aided Process Planning : Process capability analysis, Types of generative CAPP, implementation considerations. Design for Manufacturing and design for assembly.

### Unit-V

Knowledge based systems in Manufacturing: Methods of knowledge representation Introduction to Expert System, structure of ES search methodologies, expert systems in manufacturing.


## Books Recommended :

1. Groover & Zimmers, CAD/CAM, P.H.I.
2. Besant & Lui, CAD/CAM, E.W.P.
3. Groover, Production System & CIM, P.H.I.
4. Ramamurthy, Computer Graphics & CAD, T.M.H.

# MMCM – 403(C) Advance Production Technology

**Unit-I**

Modern Machining Process: Introduction and classification.

Abrasive Jet Machining: Fundamental principles, process parameters, Metal removal rate, effect of parameters, application & limitations.

Water Jet Machining: Construction, Fundamental principles, Metal removal rate, application & limitations.

**Unit-II**

Ultrasonic Machining: Fundamental principles, process parameters, cutting tool design, tool feed mechanism, transducer, Design of velocity transformers, Mechanics of cutting, Effect of parameters, Economic considerations, application & limitations.

**Unit-III**

Chemical Machining: Chemical milling, chemical engraving, chemical blanking, fundamental principles and process parameters.

Electrochemical Machining : Classification, fundamental principles, elements of process, Metal removal rate, electro-chemistry of process, Dynamics and hydrodynamics of process, optimization analysis, choice of electrolytes.

Electrochemical Grinding : Fundamental principles, electro-chemical and process parameters, Electrochemical deburring and honning.

**Unit-IV**

Electrical Discharge Machining : Mechanisms of metal removal, Basic circuitry, Evaluation of metal removal rate, Machining accuracy, Surface finish, Analysis for optimisation, tool material, dielectric fluid, application & limitation.

Plasma Arc Machining : Non-thermal generation of plasma, mechanics of metal removal, various parameters, accuracy and surface finish, applications.

**Unit-V**

Laser Beam Machining : Features, metal removal, thermal analysis, cutting speed and accuracy, application & limitation, Micro-drilling by laser.

Electron Beam Machining : Theory, forces in machining, process capability.

**Books Recommended :**
1. Pandey  P. C. & Shan H. S., Modern Machining Process, Tata McGraw Hill.
2. Dr. Bhattacharya Amitabh, The Institution of Engineers Publication, New Technology.

**References Recommended :**
   1. Production Technology,  HMT

# MMCM – 404(D) Manufacturing Automation

### Unit-I
**Fundamentals of Manufacturing and automation and production economics**: Manufacturing industries, Types of production, Functions in Manufacturing, Organization & information processing in Manufacturing, Plant layout, Production concepts and mathematical models automation strategies. Methods of evaluating investment alternatives, Costs in manufacturing, Break even analysis, unit cost of production, Cost of manufacturing, Lead time, Work in process.

### Unit-II
**High volume production systems:** Automated flow lines, Methods of work part transport, Transfer mechanism, Buffer storage, Control functions, Automation for machining operations design & fabrication consideration. Analysis of transfer lines, Partial automation, and automated flow lines with storage buffers, Computer simulation of automated flow lines.

### Unit-III
**Assembly systems and line balancing:** The assembly process, Assembly systems, Manual Assembly Lines, The line balancing problem, Methods of line balancing, Computerized line balancing methods, Improving line balancing, Flexible Manual assembly lines. Design for automated assembly, Types of automated assembly, Part feeding devices, Analysis of multi station assembly machines, Analysis of single station assembly machines.

### Unit-IV
**Programmable logic controllers**: Functions of controller, control devices, Relay device component: relays, counters, timers, switches, controller architecture, Programming PLCs: Ladder diagrams, programming examples, structured text programming, Tools for PLC logic design.

### Unit-V
**Data communication and LAN in Manufacturing:** Fundamentals of data communication: basic concepts, data coding serial and parallel data communication standards, data transfer modes, data transfer techniques, local area networks: networking technologies, topologies, medium access control, the ISO/OSI model, TCPIP protocol

**Books & References Recommended :**
1. Groover, Production System & CIM, P.H.I.
2. Zeid, CAD/CAM Theory & Practice, McGrawHill
3. Principles of computer integrated manufacturing: S. Kant Vajpayee – PHI
4. CAD CAM, Principles, Practice and Manufacturing Management, Chris McMahon, Jimme Browne- Pearson Education Asia
5. Computer Aided Manufacturing By Tien-Chien Chang, Richard A Wysk & Hsu Pin Wang, Prentice Hall of India Pvt Ltd.

W.E.F. July 2014