**ANNA UNIVERSITY, CHENNAI**

**AFFILIATED INSTITUTIONS**

**Regulation - 2013**

**B.E. INDUSTRIAL ENGINEERING**
**Curriculum and Syllabus**
**SEMESTER VII**

| SL. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| **THEORY** | | | | | | |
| 1. | IE6701 | Design of Experiments | 3 | 0 | 0 | 3 |
| 2. | GE6757 | Total Quality Management | 3 | 0 | 0 | 3 |
| 3. | IE6702 | Simulation Modeling and Analysis | 3 | 0 | 0 | 3 |
| 4. | MG6089 | Supply Chain Management | 3 | 0 | 0 | 3 |
| 5. | | Elective – III | 3 | 0 | 0 | 3 |
| 6. | | Elective – IV | 3 | 0 | 0 | 3 |
| **PRACTICALS** | | | | | | |
| 7. | IE6711 | Discrete Simulation Laboratory | 0 | 0 | 3 | 2 |
| 8. | IE6712 | Comprehension | 0 | 0 | 2 | 1 |
| | | **TOTAL** | **18** | **0** | **5** | **21** |

**Elective III**

| SL. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | IE6008 | Metrology and Inspection | 3 | 0 | 0 | 3 |
| 2. | IE6009 | Computational Methods and Algorithms | 3 | 0 | 0 | 3 |
| 3. | IE6010 | Decision Support and Intelligent Systems | 3 | 0 | 0 | 3 |
| 4. | ME6006 | Design of Jigs, Fixtures and Press tools | 3 | 0 | 0 | 3 |

**Elective IV**

| SL. NO. | COURSE CODE | COURSE TITLE | L | T | P | C |
|---|---|---|---|---|---|---|
| 1. | MG6088 | Software Project Management | 3 | 0 | 0 | 3 |
| 2. | IE6011 | Product Design and Development | 3 | 0 | 0 | 3 |
| 3. | IE6012 | Industrial Robotics | 3 | 0 | 0 | 3 |
| 4. | MF6004 | Electronics Manufacturing Technology | 3 | 0 | 0 | 3 |

**IE6701** **DESIGN OF EXPERIMENTS** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To impart knowledge on various types of experimental designs conduct of experiments and data analysis techniques.

**UNIT I FUNDAMENTALS OF EXPERIMENTAL DESIGNS 9**

Hypothesis testing – single mean, two means, dependant/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, Analysis of variance, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, testing using Analysis of variance.

**UNIT II SINGLE FACTOR EXPERIMENTS 9**

Completely Randomized Design- effect of coding the observations- model adequacy checking - estimation of model parameters, residuals analysis- treatment comparison methods-Duncan"s multiple range test, Newman-Keuel"s test, Fisher"s LSD test, Tukey"s test- testing using contrasts- Randomized Block Design – Latin Square Design- Graeco Latin Square Design – Applications.

**UNIT III FACTORIAL DESIGNS 9**

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares- $2^K$ Design with two and three factors- Yate"s Algorithm- fitting regression model- Randomized Block Factorial Design - Practical applications.

**UNIT IV SPECIAL EXPERIMENTAL DESIGNS 9**

Blocking and Confounding in $2^K$ Designs- blocking in replicated design- $2^K$ Factorial Design in two blocks- Complete and partial confounding- Confounding $2^K$ Design in four blocks- Two level Fractional Factorial Designs- one-half fraction of $2^K$ Design, design resolution, Construction of one-half fraction with highest design resolution, one-quarter fraction of $2^K$ Design

**UNIT V TAGUCHI METHODS 9**

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments- Response Graph Method, ANOVA- attribute data analysis- Robust design- noise factors, Signal to noise ratios, Inner/outer OA design.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Able to apply experimental techniques to practical problems to improve quality of processes / products by optimizing the process / product parameters.

**TEXT BOOK:**

1. Krishnaiah K, and Shahabudeen P, “Applied Design of Experiments and Taguchi Methods”, PHI,

India, 2011.

**REFERENCES:**

1. Phillip J. Ross, “Taguchi Techniques for Quality Engineering”, Tata McGraw-Hill, India, 2005.
2. Douglas C. Montgomery, “Design and Analysis of Experiments”, John Wiley & sons, 2005.

**GE6757 TOTAL QUALITY MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To facilitate the understanding of Quality Management principles and process.

**UNIT I INTRODUCTION 9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

**UNIT II TQM PRINCIPLES 9**

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

**UNIT III TQM TOOLS AND TECHNIQUES I 9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

**UNIT IV TQM TOOLS AND TECHNIQUES II 9**

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

**UNIT V QUALITY SYSTEMS 9**

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors..

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

**TEXTBOOK:**

1. Dale H. Besterfiled, et at., "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

**REFERENCES:**

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

**IE6702 SIMULATION MODELING AND ANALYSIS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To cover various aspects of discrete dynamic, stochastic systems modeling and conducting experiments with those models on a computer.

**UNIT I INTRODUCTION 3**

Systems – Modelling – Types – Systems components – Simulation basics

**UNIT II RANDOM NUMBERS / VARIATES 10**

Random numbers – Methods of generation – Random variates for standard distributions like uniform, exponential, poisson, binomial, normal etc – Testing of Random variates – Input Data Modeling - Monte Carlo Simulation.

**UNIT III DESIGN OF SIMULATION EXPERIMENTS 12**

Steps on Design of Simulation Experiments – Development of models using High level language for systems like Queuing, Inventory, Replacement, Production etc., - Model validation and verification, Output analysis. Use of DOE tools.

**UNIT IV SIMULATION LANGUAGES 12**

Need for simulation Languages – Modules of Simulation Package, Functions – Input- Reports - Study of GPSS.

**UNIT V CASE STUDIES USING SIMULATION 8**

Case studies in Queuing, Inventory, Replacement and Production

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Will be able to analyse, models and simulate experiments to meet real world system and evaluate the performance.

**TEXT BOOKS:**

1. Jerry Banks, John S Corson, Barry.L. Nelson, David M.Nicol and P.Shahabudeen, “Discrete Event Systems Simulation”, Fourth Edition, Pearson education, 2007.
2. Thomas J Schriber, “Simulation Using GPSS”, John Wiley, 2002.

**REFERENCES:**

1. Law A M and Kelton W D, "Simulation Modelling and Analysis", Tata McGraw Hill, 2003.
2. Geoffrey Gordon, “Systems Simulation”, Prentice Hall, 2002.

**MG6089 SUPPLY CHAIN MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To provide an insight on the fundamentals of supply chain networks, tools and techniques.

**UNIT I INTRODUCTION 5**

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

**UNIT II SUPPLY CHAIN NETWORK DESIGN 10**

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

**UNIT III LOGISTICS IN SUPPLY CHAIN 10**

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.

**UNIT IV SOURCING AND COORDINATION IN SUPPLY CHAIN 10**

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

**UNIT V SUPPLY CHAIN AND INFORMATION TECHNOLOGY 10**

The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The student would understand the framework and scope of supply chain networks and functions.

**TEXTBOOK:**

1. Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and Operation”, Pearson Education, 2010.

**REFERENCES:**

1. Jeremy F.Shapiro, “Modeling the Supply Chain”, Thomson Duxbury, 2002.
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management, PHI, 2010
3. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2002.
4. James B.Ayers, “Handbook of Supply Chain Management”, St.Lucle press, 2000.

**IE6711 DISCRETE SIMULATION LABORATORY L T P C**
**0 0 3 2**

**OBJECTIVES:**

- To give hands on experience with reference to computer based discrete system simulation experiments

**LIST OF EXPERIMENTS**

1. Random Number Generation Mid Square, Constant Multiplier, Congruential
2. Random variates Generation Exponential, Poisson, Normal, Binomial
3. Testing of Random variates Chi-Square, KS, Run,Poker 4-5. Monte Carlo Simulation
   Random Walk Problem with graphical application Paper Boy Problem

   6-7. Queuing Models Single, Multi Server
   8-9 Other IE oriented Models Inventory, Replacement, Production system etc.
   10-11. Use of Simulation Language/Package

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- The students would gain knowledge on computer based discrete system simulation experiments

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

1. Personal computers with following software, Language and packages
    a. C or Other equivalent Language
    b. GPSS

**IE6712 COMPREHENSION L T P C**
**0 0 2 1**

**OBJECTIVES:**

- To encourage the students to comprehend the knowledge acquired from the first Semester to Sixth Semester of B.E Degree Course through periodic exercise.

**METHOD OF EVALUATION:**

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics

**OUTCOMES:**

- ability to understand and comprehend any given problem related to mechanical engineering field.

## ELECTIVES

**IE6008 METROLOGY AND INSPECTION L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To impart knowledge about linear and angular measuring instruments.
- To impart knowledge about CMM and Machine vision system.
- To create awareness of non-destructive testing methods.

**UNIT I LINEAR MEASUREMENT AND ANGULAR MEASUREMENT 12**

Precision, Readability, Sensitivity etc., Linear measuring instruments - Accuracy, vernier–micrometer-Gauge blocks- dial indicator-comparators – Angle standards – vernier bevel protrctor-sine bar – autocollimator.

**UNIT II STANDARDS FOR LINEAR AND ANGULAR MEASUREMENTS 8**

Shop floor standards and their calibration, light interference, Method of coincidence, Slip gauge calibration, Measurement errors, Limits, fits, Tolerance, Gauges, Gauge design.

**UNIT III MEASUREMENT APPLICATION 8**

Measurement of screw threads and gears – Radius measurement – surface finish measurement - Measurement of straightness-flatness-parallelism – squareness- roundness – circularity

**UNIT IV MODERN CONCEPTS 8**

Image processing and its application in Metrology, Co-ordinate measuring machine, Types of CMM, Probes used, Application, Non-contact CMM using Electro-optical sensors for dimensional metrology

**UNIT V INTRODUCTION TO MEASUREMENT SYSTEMS 9**

System configuration, basic characteristics of measuring devices, Displacement, force and torque measurement, standards, Calibration, Sensors, Basic principles and concepts of temperature, Pressure and flow measurement, Destructive testing – Nondestructive testing.

**OUTCOMES:**

**The student must be able to** **TOTAL: 45 PERIODS**

- Apply various linear and angular measuring instruments.
- Apply measure linear, angular and surface profile using CMM.
- Apply non-destructive techniques.

**TEXT BOOK:**

1. Galyer J.F. and Shotbolt C.R, “Metrology for Engineers” ELBS, 1992.

**REFERENCES:**

1. Hune, K.J, “Engineering Metrology”, Kalyani Publishers, India, 1980.
2. Robinson, S.L. and Miller R.K, “Automated Inspection and Quality Assurance”, Marcel Dekker Inc.1989.
3. Stout, K. “Quality Control in Automation”, Prentice Hall, 1986.

**IE6009 COMPUTATIONAL METHODS AND ALGORITHMS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**OBJECTIVES:**

- A brief introduction to algorithmic design tools with some applications.

**UNIT I INTRODUCTION** **5**

Review of C/C++ - writing and debugging large programs - Controlling numerical errors.

**UNIT II ALGORITHM DESIGN METHODS 12**

Greedy – Divide and conquer – Backtracking – Branch & bound – Heuristics- Meta heuristics

**UNIT III BASIC TOOLS 12**

Structured approach – Networks – Trees – Data structures

**UNIT IV COMPUTATIONAL PERFORMANCE 6**

Time complexity – Space complexity – Algorithm complexity

**UNIT V APPLICATIONS 10**

Sorting – Searching - Networks – Scheduling – Optimization models – IE applications

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Student must be able to design algorithm computational tools used in manufacturing process.

**REFERENCES:**

1. Goodman S F and Headtruemu ST , “Introduction to design of algorithms”, McGraw Hill, 2002.
2. Sahni, “Data Structures, algorithms and applications in C++”, McGraw Hill, 2003.
3. Dromey,R.G., “How to solve it with computers?”,PHI, 2002
4. Alfred V.Aho, K Jeffrey D. Ullman and John E. Hopcroft, “Data Structures and Algorithms”, Addison -Wesley, 1993.

**IE6010 DECISION SUPPORT AND INTELLIGENT SYSTEMS L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To learn about the components of decision support system and expert systems.

**UNIT I INTRODUCTION 5**

Managerial decision making, system modeling and support - preview of the modeling process-phases of decision making process.

**UNIT II ANALYSIS 10**

DSS components- Data warehousing, access, analysis, mining and visualization-modeling and analysis-DSS development.

**UNIT III TECHNOLOGIES 10**

Group support systems- Enterprise DSS- supply chain and DSS - Knowledge management methods, technologies and tools.

**UNIT IV EXPERT SYSTEMS 10**

Artificial intelligence and expert systems - Concepts, structure, types - Knowledge acquisition and validation - Difficulties, methods, selection.

**UNIT V SEMANTIC NETWORKS 10**

Representation in logic and schemas, semantic networks, production rules and frames, inference techniques, intelligent system development, implementation and integration of management support systems.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- The students will be able to make decisions in the semi structured and unstructured problem situations using systems and semantic networks.

**TEXT BOOKS:**

1. Efraim Turban and Jay E Aronson, “Decision Support and Business Intelligent Systems”, Eighth edition, PHI, 2010.
2. Elain Rich and Kevin Knight, “Artificial intelligence”, TMH, 1993.

**REFERENCES :**

1. S S Mitra, “Decision Support Systems, Tools and Techniques”, John Wiley, 1996.

**ME6006 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design.

**UNIT I LOCATING AND CLAMPING PRINCIPLES: 8**

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

**UNIT II JIGS AND FIXTURES 10**

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

**UNIT III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES 10**

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

**UNIT IV BENDING AND DRAWING DIES 10**

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads-ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

**UNIT V OTHER FORMING TECHNIQUES 7**

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

**TOTAL: 45 PERIODS**

**Note:** (Use of P S G Design Data Book is permitted in the University examination)

**OUTCOMES:**

- Upon completion of this course, the students can able to design jigs, fixtures and press tools.

**TEXT BOOKS:**

1. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. Joshi P.H "Presstools - Design and Construction", wheels publishing, 1996

**REFERENCES:**

1. K. Venkataraman, "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.
2. Donaldson, Lecain and Goold "Tool Design", III rd Edition Tata McGraw Hill, 2000.
3. Kempster, "Jigs and Fixture Design", Hoddes and Stoughton – Third Edition 1974.
4. Hoffman "Jigs and Fixture Design" – Thomson Delmar Learning, Singapore, 2004.
5. ASTME Fundamentals of Tool Design Prentice Hall of India.
6. Design Data Hand Book, PSG College of Technology, Coimbatore.

**MG6088 SOFTWARE PROJECT MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To outline the need for Software Project Management
- To highlight different techniques for software cost estimation and activity planning.

**UNIT I PROJECT EVALUATION AND PROJECT PLANNING 9**

Importance of Software Project Management – Activities Methodologies – Categorization of Software Projects – Setting objectives – Management Principles – Management Control – Project portfolio Management – Cost-benefit evaluation technology – Risk evaluation – Strategic program Management – Stepwise Project Planning.

**UNIT II PROJECT LIFE CYCLE AND EFFORT ESTIMATION 9**

Software process and Process Models – Choice of Process models - mental delivery – Rapid Application development – Agile methods – Extreme Programming – SCRUM – Managing interactive processes – Basics of Software estimation – Effort and Cost estimation techniques – COSMIC Full function points - COCOMO II A Parametric Productivity Model - Staffing Pattern.

**UNIT III ACTIVITY PLANNING AND RISK MANAGEMENT 9**

Objectives of Activity planning – Project schedules – Activities – Sequencing and scheduling – Network Planning models – Forward Pass & Backward Pass techniques – Critical path (CRM) method – Risk identification – Assessment – Monitoring – PERT technique – Monte Carlo simulation – Resource Allocation – Creation of critical patterns – Cost schedules.

**UNIT IV PROJECT MANAGEMENT AND CONTROL 9**

Framework for Management and control – Collection of data Project termination – Visualizing progress – Cost monitoring – Earned Value Analysis- Project tracking – Change control- Software Configuration Management – Managing contracts – Contract Management.

**UNIT V STAFFING IN SOFTWARE PROJECTS 9**

Managing people – Organizational behavior – Best methods of staff selection – Motivation – The Oldham-Hackman job characteristic model – Ethical and Programmed concerns – Working in teams – Decision making – Team structures – Virtual teams – Communications genres – Communication plans.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- At the end of the course the students will be able to practice Project Management principles while developing a software.

**TEXTBOOK:**

1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi, 2012.

**REFERENCE BOOK:**

1. Robert K. Wysocki “Effective Software Project Management” – Wiley Publication,2011.
2. Walker Royce: “Software Project Management”- Addison-Wesley , 1998.
3. Gopalaswamy Ramesh, “Managing Global Software Projects” – McGraw Hill Education (India), Fourteenth Reprint 2013.

**IE6011 PRODUCT DESIGN AND DEVELOPMENT L T P C**
**3 0 0 3**

**OBJECTIVES:**

- The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

**UNIT I INTRODUCTION 5**

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

**UNIT II CONCEPT GENERATION AND SELECTION 5**

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

**UNIT III PRODUCT ARCHITECTURE 10**

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

**UNIT IV INDUSTRIAL DESIGN 10**

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

**UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 15**

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The student will be able to design some products for the given set of applications; also the knowledge gained through prototyping technology will help the student to make a prototype of a problem and hence product design and development can be achieved.

**TEXT BOOK:**

1. Kari T.Ulrich and Steven D.Eppinger, ”Product Design and Development”, McGraw-Hill International Edns. 1999.

**REFERENCES:**

1. Kemnneth Crow,”Concurrent Engg./Integrated Product Development”, DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal,”Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh,”Tool Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, New york, NY.

**IE6012 INDUSTRIAL ROBOTICS L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To introduce the basic concepts, parts of robots and types of robots.
- To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
- To discuss about the various applications of robots, justification and implementation of robot.

**UNIT I FUNDAMENTALS OF ROBOT 7**

Robot Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Their Functions – Need for Robots – Different Applications.

**UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 10**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of all these Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

**UNIT III SENSORS AND MACHINE VISION 10**

Sensory Devices - Non optical - Position sensors - Optical position sensors - Velocity sensors- Proximity sensors - Contact and noncontact type - Touel and slip sensors - Force and torque sensors - AI and Robotics.

**UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 10**

Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional)-Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs.

**UNIT V ROBOT CELL DESIGN, CONTROL AND ECONOMICS 8**

Work cell Control - Robot and machine Interface - Robot cycle time Analysis - Economic Analysis of Robots - Pay back Method, EUAC Method, Rate of Return Method.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- The Student must be able to design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

**TEXT BOOK :**

1. M.P.Groover, “Industrial Robotics – Technology, Programming and Applications”, McGraw-Hill, 2001.

**REFERENCES :**

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw-Hill Book Co., 1987.
2. Yoram Koren, “Robotics for Engineers”, McGraw-Hill Book Co., 1992.
3. Janakiraman.P.A., “Robotics and Image Processing”, Tata McGraw-Hill, 1995.
4. Richard D. Klafter., Thomas A. Chmielewski, Michael Negin, “Robotic Engineering: An Integrated Approach”, PHI.,1989.

**MF6004 ELECTRONICS MANUFACTURING TECHNOLOGY L T P C**

**3 0 0 3**

**OBJECTIVES:**

- To understand wafer preparation and PCB fabrication, the types of Mounting Technologies and components for electronics assembly and SMT process in detail.
- To know various Defects, Inspection Equipments SMT assembly process and repair, rework and quality aspects of Electronics assemblies.

**UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING 8**

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed circuit boards, types- single sided, double sided, multi layer and flexible printed circuit board, design, materials, manufacturing, inspection.

**UNIT II COMPONENTS AND PACKAGING 9**

Introduction to packaging, types-Through hole technology(THT) and Surface mount technology(SMT), Through hole components – Axial, radial, multi leaded, odd form. Surface-mount components - Active,

passive. Interconnections - Chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

**UNIT III SURFACE MOUNT TECHNOLOGY PROCESS 9**

Introduction to the SMT Process, SMT equipment and material handling systems, handling of components and assemblies - Moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - Solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement- equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, Cp and Cpk and process control. soldering- Reflow process, process parameters, profile generation and control, solder joint metallurgy, adhesive, underfill and encapsulation process - applications, materials, storage and handling, process and parameters.

**UNIT IV INSPECTION AND TESTING 9**

Inspection techniques, equipment and principle - AOI, X-ray. Defects and Corrective action - Stencil printing process, component placement process, reflow soldering process, underfill and encapsulation process, electrical testing of PCB assemblies- In circuit test, functional testing, fixtures and jigs.

**UNIT V REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS ASSEMBLIES 7**

Repair tools, methods, rework criteria and process, thermo-mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, reworkability, testing, reliability, and environment.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- Perform fabrication of PCBs and use of mounting technology for electronic assemblies.
- Perform quality inspection on the PCBs

**TEXT BOOKS:**

1. Prasad R., “Surface Mount Technology – Principles and Practice”, Second Edition, Chapman and Hall, New York, 1997
2. Tummala R.R., “Fundamentals of Microsystem Packaging”, McGraw Hill, 2001

**REFERENCES:**

1. Puligandla Viswanadham and Pratap Singh, “Failure Modes and Mechanisms in Electronic Packages”, Chapman and Hall, New York, 1997, ISBN 0-412-105591-8.
2. Totta P., Puttlitz K. and Stalter K., “Area Array Interconnection Handbook”, Kluwer Academic Publishers, Norwell, MA, USA, 2001, ISBN 0-7923-7919-5.
3. Lee N.C., “Reflow Soldering Process and Trouble Shooting SMT,BGA, CSP and Flip Chip Technologies”, Elsevier Science, 2001.
4. Zarrow P. and Kopp D. “Surface Mount Technology Terms and Concepts”, Elsevier Science and Technology, 1997, ISBN 0750698756.
5. Harper C.A., “Electronic Packaging and Interconnection Handbook” Second Edition, McGraw Hill Inc., New York, 1997, ISBN 0-07-026694-8.
6. Martin B. and Jawitz W., “Printed Circuit board materials handbook”, McGraw-Hill Professional, 1997.
7. Lau J.H., “Ball Grid Array Technology”, McGraw-Hill Professional, 1997.
8. www.ipc.org.

**TOTAL : 30 PERIODS**