

M. Tech - Design Engineering

PR	QUANTITATIVE TECHNIQUES AND QUALITY TOOLS	3	1	0	4
1.	Introduction : Operation Research (OR) – History, Concept, Applications - Basic Statistical Concepts, Characteristic, Individual, Population, Sample, Parameter, Static, Sampling and Non-sampling Error, Inductive Inference, Brief Acquaintance with Different Stages of a Statistical Investigation, Sampling Design.				9 3 0
2.	Summerisation of Data and Distribution : Frequency Distribution, Check Sheets, Run Charts, Stratification, Histogram, Measures of Central Tendency, Dispersion, Kurtosis, Skewness and Moments. Binomial, Poisson, Uniform, Normal, Exponential, Sampling Distributions.				9 3 0
3.	Estimation : Properties of Good Estimate, Unbiasedness, Consistency, Sufficing, Efficiency, Point and Interval Estimates, Maximum Likelihood, Least Squares, Scatter Diagram, Regression and Correlation and Method of Moments.				9 3 0
4.	Testing of Hypothesis : Power of a Test. Tests of Significance, Goodness of Fit, Contingency, Chi-Square, t and f tests. Barlett's Test and Sample Non-parametric Tests.				9 3 0
5.	Quality Tools : New Quality Tools, N7, Arrow Diagram Affinity Diagram, Relative Diagram, Data Matrix Diagram, Analysing PDPC Chart, Tree Diagram, KAIZAN – KAI-KA-KU – Lean Six Sigma.				9 3 0
					Total 60 hrs

References:

1. Irwin Miller and John E. Freund, "Probability and Statistics for Engineers", Prentice Hall of India, 1981.
2. John B. Kennedy and Adam M. Neville, "Basic Statistical Methods for Engineers", Harper and Row Publishers, New York, 1986.
3. Richard I. Levin and Rubin, "Statistics for Management", PHI, 1991.
4. Juran, J.M. And Frank M. Granya Jr., "Quality Planning and Analysis", Tata McGraw Hill, 2002.
5. Juran, J.M. And Frank M. Granya Jr., "New Management Tools", Quality Circle Forum of India, 2002.

ME	CONCEPTS OF ENGINEERING DESIGN	3	0	0	3
1.	The Design Process : The Design Process - Morphology of Design - Design Drawings - Computer Aided Engineering - Designing of Standards - Concurrent Engineering - Product Life Cycle - Technological Forecasting - Market Identification - Competition Benchmarking - Systems Engineering - Life Cycle Engineering - Human Factors in Design - Industrial Design.				12 0 0
2.	Design Methods : Creativity and Problem Solving - Product Design Specifications - Conceptual Design - Decision Theory - Decision Tree - Embodiment Design - Detail Design - Mathematical Modeling - Simulation - Geometric Modeling - Finite Element Modeling - Optimization - Search Methods - Geometric Programming - Structural and Shape Optimization.				12 0 0
3.	Material Selection Processing and Design : Material Selection Process - Economics - Cost Vs Performance - Weighted Property Index - Value Analysis - Role of Processing in Design - Classification of Manufacturing Process - Design for Manufacture - Design for Assembly - Design for Castings, Forging, Metal Forming, Machining and Welding - Residual Stresses - Fatigue, Fracture and Failure.				12 0 0
4.	Engineering Statistics and Reliability : Probability - Distributions - Test of Hypothesis - Design of Experiments - Reliability Theory - Design for Reliability – Reliability Centered Maintenance.				12 0 0
5.	Quality Engineering : Total Quality Concept - Quality Assurance - Statistical Process Control - Taguchi Methods - Robust Design – Failure Model Effect Analysis.				12 0 0
					Total 60 hrs

References:

1. Pahl, G, and Beitz, W., "Engineering Design", Springer - Verlag, New York. 1984.
2. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw Hill Edition 2000.
3. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Mechanical Engineering Series, 1991.
4. Suh, N.P., "The principles of Design", Oxford University Press, New York, 1990.
5. Ray, M.S., "Elements of Engg. Design", Prentice Hall Inc., 1985.

ME	DESIGN FOR MANUFACTURING AND ASSEMBLY	4	0	0	4
1.	Geometric Analysis : Process Capability - Feature Tolerances - Geometric Tolerances - Tolerance Grades - Analysis of Tapers and Screw Threads.				12 0 0
2.	Form Design of Castings and Weldments : Redesign of Castings based on Parting Line Considerations - Minimizing Core Requirements - Redesigning of Cast Members using Weldments.				12 0 0
3.	Computer Control in Manufacturing Systems : DNC and CNC - Adaptive Control of Manufacturing Processes - Manufacturing System Concepts - Computer Processes - Monitoring and Control - Off Line use of Computers, CAD, Computer Process Interface - Programming Introduction to FMS.				12 0 0
4.	Computer Integrated Manufacturing : Software Tools for CIM - Basics of DBMS, DSS, Distributed Computing and LAN and FAN and WAN Shop Floor - Automation and Automatic Identification Techniques - CAD/ CAM - Robotics in Industry - Robotized Assembly - GT Applications - FMS Analysis - Automated Material Handling.				12 0 0
5.	Manufacturing Automation : Automation Strategies - Flow Lines - Automated Assembly Systems - Transfer Systems Vibratory Bowl Feeders - Non Vibratory Feeders - Part Orienting, Feed Track, Part Placing and Part Escapement Systems - Programmable Automation.				12 0 0
					Total 60 hrs

References:

1. David M. Anderson, "Design for Manufacturing - Optimizing Cost, Quality and Time to Market, 2nd Edition, CIM Press, 2001.
2. Harry Peck, "Designing for Manufacture", Pitman Publications, 1983.
3. Dr. Sadhu Singh, "Computer Aided Design and Manufacturing", Khanna Publishers, 2nd Edition, 2000 May.
4. Ibrahim Zeid, "CAD/CAM", Tata McGraw Hill, 1998.
5. Geoffrey Boothroyd, et. al., "Product Design for Manufacture & Assembly", Marcal Dekker Inc., 2001.

ME	MATERIALS MANUFACTURING AND DESIGN	4	0	0	4
1.	Materials Classification : Overview, Mechanical Properties of Materials. Selection of Materials for Design Needs. Case Studies.				12 0 0
2.	Manufacturing Processes : Metal Forming, Metal Casting, Metal Stamping, Extrusion, Metal Cutting, EDM, Centrifugal Casting, ECM, AJM, Structural Foam Molding, Rotational Molding, Blow Molding, Thermo Forming, Vacuum Forming, Welding of Plastics, Gas Assisted Injection Molding. Corrosion – Plating / Inorganic Metal Finishes Passivity, Corrosion of Metals; Corrosion Prevention: Plating, Conversion Coatings, Anodizing and Inhibition.				12 0 0
3.	Composite Materials : Fiber / Matrix Systems, Processing and Applications Composites Individual Project Assigned Ceramics Chemistry and Structure of Ceramics; Glass (Amorphous) Structures, Processing, Applications, Ceramic Processing, Mechanical Properties, Properties and Applications of Advanced Ceramics.				12 0 0
4.	Polymer Chemistry : Molecular Structure Properties: Thermoplastics / Thermostats, Elastomer, Applications. Materials for Prototype Building like Wood, Paper, Clay, Plaster of Paris etc., and Types, Manufacturing Processes involved using these Materials. Processing, Specific Applications of Polymer Systems.				12 0 0
5.	Advanced Techniques : The use and Application of other Shaping Technology such as EDM, Wear Erosion, Gas Cutting, Laser Machining, Water Jet Processing will be examined. Materials for Rapid Prototyping Techniques, Selection.				12 0 0
					Total 60 hrs

Reference :

1. W.D. Callister, "Materials Science and Engineering", 5th Edition, John Wiley and Sons, 1999.
2. Ashby .MF, "Materials Selection in Mechanical Design". Oxford: Butterworth - Heinemann, 1992.
3. "Manufacturing Engineering and Technology", Kalpakjan, 3rd Edition, Addison Wesley, 2000.
4. Steen .W .M, "Laser Material Processing", Second Edition, Springer -Verlag, 1991.
5. Lindberg Roy .A, "Processes and Materials of Manufacture", 4th Edition, Allyn and Bacon, 1990.
6. Crawford .R.J, "Plastics Engineering", 2nd Edition, Oxford: Pergamon.

ME	COMPUTER AIDED DESIGN AND MANUFACTURING	3	0	0	3
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- CAD / CAM / Hardware/ Software** : Types of Computer Systems - Input devices - Output devices - CAD/CAM Software - Graphics standards - Basic Definitions Modes of Graphics Operations - User Interface - Software modules - Modeling and Viewing - Software Development - Efficient use of CAD/CAM Software - Microcomputer based CAD/CAM. **12 0 0**
 - Two Dimensional and Three Dimensional Transformations** : 2D - Representation and Transformation of Points - Transformation of Lines - Rotation, Reflection, Scaling and combined transformations - 3D scaling - shearing - Rotation - Reflection - Translation - Projections parametric representation of Ellipse, Parabola, Hyperbola. **12 0 0**
 - Modeling and Analysis** : Wire frame, Surface and Solid modelling - Solid modelling packages - Finite Element Analysis (FEA) - Introduction and procedures - Solution Techniques - Introduction to FEA packages. **12 0 0**
 - Computer Aided Manufacture** : Manufacturing Planning and Control - CAD/CAM Integration - Principles of Computer Integrated Manufacturing - Hierarchical Network of Computers - Local Area Networks - Process Planning - Computer Aided Process Planning - Retrieval and Generative approaches. **12 0 0**
 - Production Planning and Shop Floor Control** : Computer Integrated Production Management System - Master Production Schedule - Material Requirement Planning – Inventory Management - Manufacturing and Design Data Base - Capacity Planning - Shop Floor Control - Functions – Order Release - Order Scheduling - Order Progress - Factory Data Collection. **12 0 0**
- Total 60 hrs**

References :

- Ibrahim Zeid, "CAD/CAM, Theory and Practice", Tata McGraw Hill Ed., 1998.
- David F. Rogers and Alan Adams .J, "Mathematical Elements for Computer Graphics", McGraw Hill Publishing Company International Edition, 1990.
- William M. Newman, Robert F. Sproull, "Principles of Interactive Computer Graphics", McGraw Hill international Book Company, 1984.
- Groover M.P., Automation, "Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt. Ltd., New Delhi, 1996.
- Paul G. Ranky, "Computer Integrated Manufacture", Prentice Hall International, UK, 1986.

PR	EMERGING ENGINEERING TECHNOLOGIES	3	0	0	3
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- Engineering Technologies & Systems and Critical Technologies** : Overview - Micro and Nanotechnologies, MEMS, MOEMS. **10 0 0**
 - Interdisciplinary Approach** : Engineering, Biology & Medical Technologies - Engineering disciplines & Applications - Biological disciplines & Applications - Medical disciplines & Applications. **12 0 0**
 - Genomics** : Biotechnologies, DNA, Protein, Tissue Engineering, Bioinformatics. **8 0 0**
 - Cognitive Engineering** : Nanotechnologies, Nanotubes, Molecular Manufacturing - Molecular Nanotechnology - I.T. - Artificial Intelligence, Robotics, Informatics, Human - Computer interaction, Neural Networks - Smart Materials - Microfabrication – Sensors. **15 0 0**
 - Role of Emerging Technologies and its Applications** : Energy & Environmental - Defence & Aerospace - Construction & Infrastructure - Information & Electronic Industry - Pharmaceuticals & Medicine - Food & Agricultural Sector. **15 0 0**
- Total 60 hrs**

References :

- Nadim Maluf, "An Introduction to Microelectromechanical Systems Engineering", (Artech House MEMS Library) Artech House; ISBN : 0890065810; (December 1999).

2. Sergey Edward Lyshevski, "Nano and Microelectromechanical Systems ; Fundamentals of Nano and Microengineering", CRC Press; ISBN : 0849309166; (September 25, 2000)
3. "Report on Critical Technologies – Overview", NDRF Publication, 2002.

ME	FINITE ELEMENT ANALYSIS	3	1	0	4
1.	Finite Element Analysis : Historical Background - Weighted Residual Methods - Basic Concept of FEM - Variational Formulation of B.V.P. - Ritz Method - Finite Element Modeling – Element - Equations - Linear and Quadratic Shape functions - Bar, Beam Elements - Applications to Heat Transfer.				9 3 0
2.	Finite Element Analysis of 2D Problems : Basic Boundary Value Problems in 2 Dimensions - Triangular, Quadrilateral, Higher Order Elements - Poissons and Laplaces Equation - Weak Formulation - Element Matrices and Vectors - Application to solid mechanics, Heat transfer, Fluid Mechanics.				9 3 0
3.	Iso-Parametric Formulation : Natural Co-ordinate Systems - Lagrangian Interpolation Polynomials - Isoparametric, Elements - Formulation - Numerical Integration - ID - IID Triangular Elements - Rectangular Elements - Illustrative Examples.				9 3 0
4.	Solution to Plane Elasticity Problems : Introduction to Theory of Elasticity - Plane Stress - Plane Strain and Axisymmetric Formulation - Principle of Virtual Work - Element Matrices using Energy Approach.				9 3 0
5.	Special Topics : Dynamic Analysis - Equation of Motion - Mass Matrices - Free Vibration analysis - Natural Frequencies of Longitudinal - Transverse and Torsional Vibration - Introduction to Transient Field Problem. Nonlinear Analysis. Use of Software's - h & P Elements - Special Element Formulation.				9 3 0
					Total 60 hrs

References:

1. Reddy .J.N, "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 1993.
2. Segerlind L.J., "Applied Finite Element Analysis", John Wiley, 1984
3. Rao S.S., "Finite Element Method in Engineering", Pergamon Press, 1989.
4. Chandrupatla & Belagundu, "Finite Elements in Engineering", Prentice Hall of India Private Ltd., 1997.
5. Cook, Robert Davis et. al, " Concepts and Applications of Finite Element Analysis ", Wiley John & Sons, 1999.
6. George R Buchaman , " Schaum's Outline of Finite Element Analysis", McGraw Hill Company, 1994.

PR	PRODUCT LIFE CYCLE MANAGEMENT	3	0	0	3
1.	Introduction : Introduction to Product Data Management (PDM) – Present Market Constraints – Need for Collaboration – Internet and Developments in Server – Client Computing.				6 0 0
2.	Components of PDM : Components of a Typical PDM Setup – Hardware and Software Document Management – Creation and viewing of Documents - Creating Parts – Version and Version Control of Parts and Documents – Case Studies.				12 0 0
3.	Configuration Management : Base Lines – Product Structure – Configuration Management – Case Studies.				10 0 0
4.	Life Cycle Management : Creation of Projects and Roles – Life Cycle Management – Automating Information Flow - Work Flow – Creation of Work Flow Templates – Life Cycle – Work Flow Integration – Case Studies. Change Management : Change Issue – Change Request – Change Investigation – Change Proposal – Change Activity – Case Studies.				20 0 0
5.	Generic Products and Variants : Product Configuration – Comparison between Sales Configuration and Product Configurator – Generic Product Modeling in Configuration Models – use of order Generator for variant Creation – Registering of Variation in Product Register – Case Studies.				12 0 0
					Total 60 hrs

References :

1. David Bedworth, Mark Henderson & Philip Wolfe, "Computer Integrated Design and Manufacturing", McGraw Hill Inc., 1991.
2. Terry Quatrain, "Visual Modeling with Rational Rose and UML", Addison Wesley, 1998.
3. Wind-chill R5.0 Reference Manuals, 2000.

ME	CONCURRENT ENGINEERING	3	0	0	3
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1. **Introduction** : Extensive definition of Concurrent Engineering (CE) - CE Design Methodologies - Organizing for CE - CE Tool Box Collaborative Product Development. 12 0 0
 2. **Use of Information Technology** : IT Support - Solid Modeling - Product Data Management - Collaborative Product Commerce - Artificial intelligence - Expert Systems - Software Hardware Co-design. 12 0 0
 3. **Design Stage** : Life-cycle Design of Products - Opportunity for Manufacturing Enterprises - Modality of Concurrent Engineering Design- Automated Analysis Idealization Control - Concurrent Engineering in Optimal Structural Design - Real Time Constraints. 12 0 0
 4. **Manufacturing Concepts and Analysis** : Manufacturing Competitiveness - Checking the Design Process - Conceptual Design Mechanism - Qualitative Physical Approach - An Intelligent Design for Manufacturing System - Jit System - Low Inventory - Modular - Modeling and Reasoning for Computer Based Assembly Planning - Design of Automated Manufacturing. 12 0 0
 5. **Project Management** : Life Cycle Semi Realization - Design for Economics - Evaluation of Designs for Manufacturing Cost - Concurrent Mechanical Design - Decomposition in Concurrent Design - Negotiation in Concurrent Engineering Design Studies - Product Realization Taxonomy - Plan for Project Management on New Product Development - Bottleneck Technology Development. 12 0 0
- Total 60 hrs**

Reference:

1. Andrew Klisiak, "Concurrent Engineering : Automation, Tools and Technology", Wiley John & Sons Inc., 1992.
2. Prasad, "Concurrent Engineering Fundamentals : Integrated Product Development", Prentice Hall, 1996.
3. Anderson MM and Hein L, Berlin, "Integrated Product Development", Springer Verlag, 1987.
4. Cleetus J, "Design for Concurrent Engineering", Concurrent Engg. Research Centre, Morgantown, WV; 1992.
5. Sammy G Sinha, "Successful Implementation of Concurrent Product and Process", W. John and Sons Inc., 1998.

ME	ADVANCED FINITE ELEMENT ANALYSIS	3	1	0	4
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1. **Bending of Plates and Shells** : Review of Elasticity Equations - Bending of Plates and Shells - Finite Element Formulation of Plate and Shell Elements - Conforming and Nonconforming Elements C_0 and C_1 Continuity Elements - Application and Examples. 9 3 0
 2. **Non-Linear Problems** : Introduction - Iterative Techniques - Material Non-linearity - Elasto Plasticity - Plasticity - Visco Plasticity - Geometric Non-linearity - Large Displacement Formulation Application in Metal Forming Process and Contact Problems. 9 3 0
 3. **Dynamic Problem** : Direct Formulation - Free, Transient and Forced Response - Solution Procedures - Subspace Iterative Technique - Houbolt, Wilson, Newmark - Methods - Examples. 9 3 0
 4. **Fluid Mechanics and Heat Transfer** : Governing Equations of Fluid Mechanics - Inviscid and Incompressible Flow - Potential Formulations - Slow Non-Newtonian Flow - Metal and Polymer Forming - Navier Stokes Equation - Steady and Transient Solution. 9 3 0
 5. **Error Estimates and Adaptive Refinement** : Error Norms and Convergence Rates - h refinement with Adaptivity - Adaptive Refinement. 9 3 0
- Total 60 hrs**

References:

1. Zienkiewicz, O.C. and Taylor .R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
2. Cook R.D., "Concepts and Applications of Finite Element Analysis", John Wiley and Sons Inc., New York, 1989.

3. Bathe .K.J, "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.

ELECTIVES

ME	MULTI-OPTIMIZATION IN ENGINEERING DESIGN	3	0	0	3
1.	Introduction : Optimization in Context of Other Decision Support Tools - OR Models in Design and Manufacturing - Computer-based Solution Tools - Verification and Validation. Single versus Multi-Objective Models : Multi-objective Formulations (Baseline Model, Goal Programming, etc). Multi-objective Solution Algorithms. Multi-objective Evolutionary Algorithms (MOEAs) - Converting Single Objective Algorithms into Multi-objective Algorithms. DFX Models : Modeling Product Performance and Efficiency - Reliability Models - Cost Models - Environmental Models - Quality and Robustness Models - Quantifying Manufacturability.				12 0 0
2.	Linear Models and Solution Methods : Linear Models in Design - Simplex Theorem, Convexity, Global and Local Extrema - Single Objective Linear Models - Simplex Algorithm - Multi-Objective Linear Models - Multiplex Algorithms - Sensitivity Analyses - Network, Transportation, and Scheduling Problems.				12 0 0
3.	Non-Linear Optimization Models and Solution Algorithms : General Scheme, Zeroeth Order, First Order, Second Order - Sensitivity Analyses and Validation - Use of Line Searches (Bracketing, Golden Section, Newton & False Position Method) - Multivariate Unconstrained Problems and Algorithms (Newton, Coordinate Descent, Conjugate Gradient Method) - Constraint Nonlinear Optimization : Difference between Constraints, Goals and Objectives in Design - Design Problem Formulations - Quasi Newton Methods, Hessian Updates, DFP and BFGS Methods - Penalty and Barrier Methods - Sequential and Adaptive Linear Programming - Quadratic Programming.				12 0 0
4.	Primal Methods : Feasible Directions Method - Active Set Methods - Gradient Projection Methods - (Generalized) Reduced Gradient Methods - Discrete and Mixed Integer Models - Catalog Design - Boolean Conversions - Branch & Bound, Cutting Plane Methods - Combinatorial Explosion - Monte-Carlo Methods - Simulated Annealing - Genetic Algorithms.				12 0 0
5.	Special Topics : Integrating Simulation in Optimization Models - Multidisciplinary Optimization - FEA Optimization - Stochastic Optimization - Robustness and Tolerance Optimization.				12 0 0
					Total 60 hrs

References:

1. G.V. Reklaitis, A. Ravindran, and K.M. Ragsdell, "Engineering Optimization - Methods and Applications", John Wiley and Sons.
2. Ignizio, J. P., "Linear Programming in Single and Multi-Objective Systems", Prentice-Hall, Englewood Cliffs, New Jersey, 1982.
3. Luenberger, D. G., Dr. Bert Bras, "Linear and Nonlinear Programming", Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, 1984.
4. Kalyanmoy Deb, "Multi-Objective Optimization Using Evolutionary Algorithms, Addison-Wesley Publishing Co., 2002.

ME	ENGINEERING DESIGN FOR SAFETY	3	0	0	3
1.	Introduction : Concept of Safety, Types of Hazards, Recognition, Avoidance and Prevention, Elimination, Design Philosophy, Review, SQP Trilogy.				12 0 0
2.	Human Factors in Design : Human Factor Design Requirements, Anthropocentric Data, Design Requirement, Safety as a Human Factor.				12 0 0
3.	Product Design Process : Problem Statement, Solutions, Design Review 1,2, Life Cycle Considerations. Design of Consumer Products, Definition, Product Safety Standards, Compliance and Enforcement, Faulty Consumer Product Design.				12 0 0
4.	Design of Industrial and Commercial Products : Regulatory Considerations, Detailed Design Requirements, Environmental Regulations, Machinery and Equipment Design, Examples.				12 0 0

5. **Product Liability** : Codes, Standards and Specifications for Design. Product Liability Insurance and Litigation, Consumer Organisations, Legal Process, Consumer Courts, Case Studies. 12 0 0
Total 60 hrs

References :

1. Thomas A. Hunter, "Engineering Design for Safety", McGraw-Hill, Inc., New York, 1992.

ME	TRIBOLOGY IN DESIGN	3	0	0	3
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1. **Surfaces, Friction and Wear** : Topography of Surfaces - Surface Features – Surface Interaction - Theory of Friction Sliding and Rolling Friction, Friction Properties of Metallic and Non-metallic Materials Friction in Extreme Conditions - Wear, Types of Wear - Mechanism of Wear - Wear Resistance Materials - Surface Treatment - Surface Modifications - surface coatings. 12 0 0
2. **Lubrication Theory** : Lubricants and their Physical Properties Lubricants Standards - Lubrication Regimes Hydrodynamic Lubrication - Reynolds Equation, Thermal, Inertia and Turbulent Effects Elasto Hydrodynamic and Plasto Hydrodynamic and Magneto Hydrodynamic Lubrication – Hydro Static Lubrication - Gas Lubrication. 12 0 0
3. **Design of Fluid Film Bearings** : Design and Performance Analysis of Thrust and Journal Bearings - Full, Partial, Fixed and Pivoted Journal Bearings Design - Lubricant Flow and Delivery - Power Loss, Heat and Temperature Rotating Loads and Dynamic Loads in Journal Bearings - Special Bearings Hydrostatic Bearing Design. 12 0 0
4. **Rolling Element Bearings** : Geometry and Kinematics - Materials and Manufacturing Processes - Contact Stresses - Hertzian Stress Equation – Load Divisions - Stresses and Deflection - Axial Loads and Rotational Effects, Bearing Life Capacity and Variable Loads - ISO Standards - Oil Films and their Effects - Rolling Bearings Failures. 12 0 0
5. **Tribo Measurement in Instrumentation** : Surface Topography Measurements - Electron Microscope and Friction and Wear Measurements - Laser Method - Instrumentation - International Standards – Bearings Performance Measurements - Bearing Vibration Measurement. 12 0 0
Total 60 hrs

References:

1. Cameron .A, "Basic Lubrication Theory", Ellis Herward Ltd., OK, 1981.
2. Hulling .J. (Editor) -"Principles of Tribology ", Mac Milan, 1984.
3. Williams .J.A, "Engineering Tribology", Oxford University Press, 1994.
4. Neale .M.J, "Tribology Hand Book", Butterworth Heinemann, 1995.

ME	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	3	0	0	3
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1. **Introduction** : Productivity Concepts - Macro and Micro Factors of Productivity, Productivity Benefit Model, Productivity Cycle.
2. **Productivity Models** : Productivity Measurement at International, National and Organisation Level, Total Productivity Models. Productivity Management in Manufacturing and Service Sector. Productivity Evaluation Models, Productivity Improvement Models and Techniques.
3. **Organisational Transformation** : Principles of Organisational Transformation and Re-Engineering, Fundamentals of Process Reengineering, Preparing the Workforce for Transformation and Re-engineering, Methodology, Guidelines, DSMCQ and PMP Model.
4. **Re-Engineering Process Improvement Models** : PMI models, Edosomwan Model, Moen and Nolan Strategy for Process Improvement, LMICIP Model, NPRDC Model.
5. **Re-Engineering Tools and Implementation** : Analytical and Process Tools and Techniques - Information and Communication Technology - Enabling Role of IT, RE - Opportunities, Process Redesign - Cases. Software Methods in BPR - Specification of BP, Case Study - Order, Processing, User Interfaces, Maintainability and Reusability. 12 0 0

References :

1. Sumanth, D.J., "Productivity Engineering and Management", TMH, New Delhi, 1990.
2. Edosomwan, J.A., "Organisational Transformation and Process Re-Engineering", British Library Cataloging in Pub. Data, 1996.
3. Rastogi .P.N, "Re-Engineering and Re-inventing the Enterprise", Wheeler pub. New Delhi, 1995.
4. Premvrat Sardana .G.D and Sahay .B.S, "Productivity Management - A Systems Approach", Narosa Pub. New Delhi, 1998.

PR	REVERSE ENGINEERING	3	0	0	3
1.	Introduction : Scope and Tasks of Reverse Engineering (RE) - Domain Analysis- Process of Duplicating.				9 0 0
2.	Tools for RE : Functionality - Dimensional - Developing Technical Data - Digitizing Techniques - Construction of Surface Model - Solid-Part Material - Characteristics Evaluation -Software and Application Prototyping – Verification.				12 0 0
3.	Concepts of RE : History of RE - Preserving and Preparation for the Four Stage Process - Evaluation and Verification - Technical Data Generation, Data Verification, Project Implementation.				15 0 0
4.	Data Management : Data Reverse Engineering - Three Data Reverse Engineering Strategies - Definition - Organization Data Issues - Software Application - Finding Reusable Software Components - Recycling Real-time Embedded Software - Design Experiments to Evaluate a RE Tool- Rule based Detection for RE User Interfaces – RE of Assembly Programs : A Model based Approach and its Logical Basics.				12 0 0
5.	Integration : Cognitive approach to Program Understated - Integrating Formal and Structured Methods in RE - Integrating RE, Reuse and Specification Tool Environments to RE - Coordinate Measurement - Feature Capturing - Surface and Solid Members.				12 0 0
					Total 60 hrs

Reference:

1. Katheryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.
2. Linda Wills, "Reverse Engineering", Kluiver Academic Publishers, 1996.
3. Aiken, Peter, "Data Reverse Engineering", McGraw-Hill, 1996.
4. Donald R. Honsa, "Co-ordinate Measurement and Reverse Engineering", ISBN 1555897, American Gear Manufacturers Association.
5. S. Rugaban, Technical Report, "White Paper on RE", Georgia Instt. of Technology, 1994.
6. T J Biggerstaff, "Design Recovery for Maintenance and Reuse", IEEE Corpn., July, 1991.

ME	CREATIVITY AND INNOVATION MANAGEMENT	3	0	0	3
1.	Introduction : Need for Creativity and Innovations – Need for Design Creativity - Creative Thinking for Quality - Essential Theory About Directed Creativity - Definitions and Theory of Mechanisms of Mind Heuristics and Models : Attitudes, Approaches and Actions that support Creative Thinking – Lateral Thinking.				12 0 0
2.	Mechanism of Thinking and Visualization : Advanced Study of Visual Elements and Principles - Line, Plane, Shape, Form, Pattern, Texture Gradation, Color Symmetry. Spatial Relationships and Compositions in 2 and 3 Dimensional Space - Procedure for Genuine Graphical Computer Animation - Animation Aerodynamics - Virtual Environments in Scientific Visualization - Unifying Principle of Data Management for Scientific Visualization - Unifying Principle of Data Management for Scientific Visualization - Visualization Benchmarking.				12 0 0
3.	Directed Creativity : Methods and Tools for Directed Creativity - Basic Principles - Tools of Directed Creativity - Tools that prepare the mind for creative thought - Stimulation of New Ideas - Development and Actions : The Bridge between Man Creativity and the Rewards of Innovativeness - Applying Directed Creativity to the Challenge of Quality Management.				12 0 0

4. **Design & Implementation** : Process Design, Recycling and Availability - Creativity and Customer Needs Analysis - Innovative Product and Service Designs, Future Directions in this Application of Creativity Thinking in Quality Management. Achieving creativity - the Essential Factors - Mind Mapping - Force Field Analysis - The Game - Introduction - Uses of the Game - Pre-game Preparation - Playing the Game - The Seven Creative Prompts Lists - Walking the Talks: Taking Action - Ben Balance - Work Sheet - Celebrations Document - Sniper Trap. 12 0 0
 5. **Innovation** : Activities and Heuristics Related to Development and Action Models for Organisational Change – Tools for Development and Action Phases – Re-engineering – Directed Creativity. 12 0 0
- Total 60 hrs**

Reference:

1. Rousing Creativity : Think New NowFloyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999.
2. Pradeep N. Khandawala, "Fourth Eye, Excellence Through Creativity", A.H. Wheeler & Co. Pvt. Ltd, Allahabad, 1984.
3. Morgan, Gareth, "Imagination - The Art of Creative Management", Sage Publications, 1993.
4. P.N. Rastogi, Managing Creativity for Corporate Excellence, Macmillan India, Madras, 1996.
5. Subrata Dasgupta, "Technology and Creativity", Oxford University Press, New York, 1996.
6. Paul .E Plesk, "Creativity, Innovation and Quality", PHI 2000.
7. Harry Nystrom, "Creativity and Innovation", John Wiley and Sons, 1979.

ME	PRODUCT DESIGN AND DEVELOPMENT STRATEGIES	3	0	0	3
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1. **Introduction** : Need for PDDS - Strategic Importance of Product development - Integration of Customer, Designer, Material Supplier and Process Planner, Competitor and Customer-behavior Analysis Understanding Customer - Promoting Customer Understanding - Involve Customer in Development and Managing Requirements - Organization - Process Management and Improvement - Plan and Establish Product Specifications. 12 0 0
 2. **Concept Generation and Selection** : Task - Structured Approaches – Clarification – Search - Externally and Internally - Explore Systematically - Reflect on the Solutions and Processes - Concept Selection - Methodology - Benefits. 12 0 0
 3. **Product Architecture** : 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. 12 0 0
 4. **Industrial Design** : 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 Customer Needs - Conceptualization - Refinement - Management of the Industrial Design Process -Technology Driven Products - User Driven Products - Assessing the Quality of Industrial Design. 12 0 0
 5. **Design for Manufacturing and Product Development** : 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 - N.S.A Consumer Product Design Project is Recommended. 12 0 0
- Total 60 hrs**

Reference :

1. Karl T Ulrich and Steven D. Eppinger, "Product Design and Development", MG-Hill International Edns. 1999.
2. Kemnneth Crow, "Concurrent Engg. / Integrated Product Development", DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274 (310) 377-569, Workshop Book.
3. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN : 1-55623-603-4.
4. Stuart Pugh, "Tool Design - Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New York, 1991, ISBN 0-202-41639-5.

PR	OPTIMIZATION TECHNIQUES	3	1	0	4
1.	Linear Programming : The L.P. Model, Assumptions, Solving by Graphical and Simplex Method, Post Optimality Analysis, The Transportation Problem, The Assignment Problem.				9 3 0
2.	Networks and Decision Analysis : PERT, CPM, The Shortest Path - Minimal Spanning Tree - Maximum Flow Problems. Decision Making without and with Experimentation, Decision Trees, Game Theory.				9 3 0
3.	Markov Processes : Basic Structure of Queuing Models, Application of Queuing Theory, Markov Chains.				9 3 0
4.	Dynamic Programming: Characteristics of D.P. Problems, Deterministic Dynamic Programming, Goal Programming.				9 3 0
5.	Multi-objective Optimization : Methods and Application, Formulation of Problems – Separate Programming and Stochastic Programming.				9 3 0
					Total 60 hrs

References:

1. Ravindran - Phillips and Solberg, "Operations Research Principles and Practice", John Wiley and Sons, 1987.
2. F.S. Hillier, G.L. Liberman, "Introduction to Operations Research" McGraw Hill, 1995.
3. Singiresu .S Rao, "Engineering Optimization – Theory and Practices", John Wiley and Sons, 1998.

PR	CLEANER PRODUCTION TECHNIQUES	3	0	0	3
1.	Cleaner Production : Introduction - Industrial and Commercial Sector Development and Related Energy and Environmental Issues. Cleaner Production(CP) Definition and Role in Industrial and Commercial Sector – Link with Sustainable Production and Consumption Concepts – Life Cycle Analysis – Extended Producer Responsibility – Pollution Prevention Vs Pollution Control – Overview on Cleaner Production – Explanation of What is Pollution Control and the Technologies associated with it – Approaches and means of Pollution Prevention.				12 0 0
2.	Energy and Environmental Parameters / Concepts for CP : Basic Technology, Units, Measurement Techniques, Significance etc. (BOD, COD, TSS, TDS, Colour, etc.) Waste and Energy Audit Methodologies – Application of Mass and Energy Audit Methodologies. Application of Mass and Energy Balance in Energy of and Environmental Audit – Sankey Diagram.				12 0 0
3.	Major Industrial Processes Considering Energy and Environmental Points of View : Identification of Major Unit Processes Associated with Energy Consumption and Pollution Generation.				12 0 0
4.	Pollution Prevention Through Process Integration (Energy & Environment) : Process Optimization by Integrating both Energy and Environmental Aspects – Energy Management Concepts and Measures to improve Energy Efficiency. Energy and Water Pinch : An Efficient Waste minimization Tool - Occupational Health and Safety -Quality of Product and other aspects of CP.				12 0 0
5.	Financial Analysis of CP Options : Cash Flow - Payback Period – Net Present Value – Internal Rate of Return – Profitability Index – Depreciation etc. Environmental Pollution and Resource Use : Design for Recycling – Life Studies – LCA Package.				12 0 0
					Total 60 hrs

References :

1. Rossiter .A.P, "Waste Minimization through Process Design", McGraw Hill, ISBN : 007053957, 1995.
2. Nemerow .N.L, "Zero Pollution for Industry – Waste Minimization through Industrial Complexes", John Wiley & Sons, ISBN : 0471121649, 1995.
3. Paul .L Bishop, "Pollution Prevention : Fundamentals and Practice", McGraw Hill, ISBN : 0-07-116058-2, 2000.
4. Modak .P, Viswanathan .C & Parasnis .M, "Cleaner Production Audit", Review No. 32, ENSIC, AIT, 1997.
5. "United Nation Environment Programme", "Cleaner Production Training Manual", 1996.
6. "United Nations Environment Programme, Industry and Environment, Company Environmental Reporting, A Measure of the Progress of Business & Industry towards Sustainable Development", 1994.
7. "UNEP/IE, Audit and Reduction Manual for Industrial Emissions and Wastes", Tech. Report No. 7, 1991.

ME	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3
1.	Introduction : Equations for Incompressible Planar Flows, Stream Functions and Vorticity Equations, Conservative Form, Normalising Systems, Transport Equations.				12 0 0
2.	Different Methods of CFD : Methods for Solving Vorticity Transport Equations, Stability Analysis : One-step Explicit Methods, Implicit Methods, Multistep Explicit Methods, ADI Methods, ADE Methods.				12 0 0
3.	Transporative and conservative differencing : Transporative and Conservative Differencing. Methods for solving Stream Function Equations : Direct Methods, Richardson’s Methods and Leihman’s Methods. SOR Method. Ourier Series Method.				12 0 0
4.	Numerical Treatment : Numerical Treatment of boundary conditions for the Vorticity and Stream Function Equation.				12 0 0
5.	Basic Computational Methods : Basic Computational methods of Compressible Flows, Methods using Explicit and Implicit Artificial Viscosities. Programming, Testing and Information Processing of Numerical Methods.				12 0 0
					Total 60 hrs

References :

ME	RAPID PROTOTYPING AND DEVELOPMENT	3	0	0	3
1.	Introduction : Perspective - Practical Applications - Basic Operation - Digital and RP Benefits - Basic Polymer Chemistry - Digital Prototyping Environment - Digital Clay - Part Building.				12 0 0
2.	Fundamental Processes : Stereolithographic Process - Lasers for RP - Gaussian Laser Beam -Working Curve Equation - Photo Modulus Model - Selective Laser Sintering - 3D Printing - FDM Techniques - Vacuum Casting Processes.				12 0 0
3.	Digital Prototyping : Introduction - Data Requirements - Solid Modeling - 3D Surface Modelers - CAD System Data Representation - Managing CAD in RP & M Environment - Digital Prototyping – System Requirements - Human Interfaces - Visualization Desk - Reality Centre - Virtual Rapid Prototyping - Immersive Software Solutions.				12 0 0
4.	Part Building : Initial Considerations - Slice Process - Building and Merging Slice Files - Customization - Build Options - Development of WEAVE™ 199 - STAR-WEAV™ 211 – Part Cleaning - Postcuring - Finishing - Diagnostic Testing - Methods - Accuracy of Parts.				12 0 0
5.	Case Studies : Case Studies - Digital Prototyping and Rapid Prototyping.				12 0 0
					Total 60 hrs

References :

1. Paul F Jacobs, “Rapid Prototyping and Manufacturing - Fundamentals of Sterolithography”, Society of Manufacturing Engineers, Dearborn, USA 1992.
2. “Digital Prototyping, A Personal Report”, by Silicon Graphics to AU-FRG ICC, 1999.
3. “Rapid Prototyping and Tooling”, Industrial Design Centre, IIT., Mumbai, 1998.

ME	MICROFABRICATION	3	0	0	3
1.	Introduction : Definition - Micromachining - Fabrication - Recent Trends – Lithography Types - Materials and Tools - Electronic and Computer Hardware Components.				12 0 0
2.	Machining Methods : Ultraprecision Machining – Emerging Lithography Technologies – Laser Beam - Ion Beam Methods for Microfabrication - Precision and Accuracy - Interferometric Measurement Systems - 3D Systems - Applications - Dry Etching and Boron Diffusion of Heavily Doped High Aspect Ratio Si Trenches – Pattern Transfer with Dry Etching Techniques – Additive Techniques.				12 0 0
3.	Microfabrication : Fabrication of Piezoxestion - Sensor AFM Cantilever Probability Integrated Tip - High - Etchable Anti Static Deep Pressure Etching for the Fabrication of Pressure Seven Components - Characteristics of Residual Stress Micromodelling - Fabrication of LIGA Mold Circuits - Pattern Quality of Thick Press to Fabricating Micromechanics 3D Structures Uni Electroplating Without Photostress Mold.				12 0 0

4. **System Components** : Microsystems Devices - Microsensors, Accelerators, Micropumps and Miniature Robots. **12 0 0**
5. **Application** : Application of Micromachining Techniques to Optical Devices & Systems – MEMS - Dry Etching and Micromachining of Precision Components - Micro Machining Scanning, Microscope for Nano-Scale Characterization and Fabrication. **12 0 0**

Total 60 hrs

References :

1. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1997.
2. James H. Smith, "Micromachining and Microfabrication", ISBN 081943471X SPIE, International Society Optical Engineering, 1999.
3. <http://www.crcpress.com/microfab>

ME	DESIGN MANAGEMENT	3	0	0	3
1.	Introduction : Designers perspective of the market.				12 0 0
2.	Designers and Psychological Issues : Perception and Errors in Perception.				12 0 0
3.	Designers Sources of Product Features : Projective Techniques to Acquire Product Feature Databases.				12 0 0
4.	Designer in a Team : Human Resources Issues a Designer must know, Designer and Competition, Collaboration and Conflict Management, Designer in an Organization.				12 0 0
5.	Designer as an Entrepreneur : Designers Knowledge on Intellectual Property.				12 0 0
					Total 60 hrs

Reference:

1. Mark Oakley (Ed), "Design Management - A Handbook of Issues and Methods", Blackwell Publication.
2. Srivatsav .A.K, et. Al, (Eds), "R&D Management", TMH Publishing Co., 1995.

PR	ERP, LOGISTICS AND SUPPLY CHAIN MANAGEMENT	3	0	0	3
1.	Introduction : Logistics- Concepts, Definitions, Approaches, Factors Affecting Logistics. Supply Chain - Basic Tasks of the Supply Chain - The New Corporate Model. Basic Concepts and Definition of ERP, Evolution of ERP, Business Transformation through ERP, ERP – Organisation, Modelling Process Implementation Issues in ERP. 12 0 0				
2.	Supply Chain Management : The New Paradigm, The Modular Company, The Network Relations, Supply Process, Procurement Process - Distribution Management. 12 0 0				12 0 0
3.	Evolution of Supply Chain Models : Strategy and Structure - Factors of Supply Chain - Manufacturing Strategy Stages, Supply Chain Progress - Model for Competing through Supply Chain Management - PLC Grid, Supply Chain Redesign - Linking Supply Chain with Customer. 12 0 0				12 0 0
4.	SCM Activity Systems, Organisation and Information System : Structuring the SC, SC and New Products, Functional Roles in SC, SC Design Frame Work, Collaborative Product Commerce (CPC). The Management Task, Logistics Organisation, The Logistics Information Systems- Topology of SC Application - MRP, ERP, Warehouse Management System, Product Data Management- Cases. 12 0 0				12 0 0
5.	International Logistics and Decision Models : Ocean Carrier Management, Import - Export Logistic Management. Decision Support Models of Supply Chain Management. 12 0 0				12 0 0
					Total 60 hrs

References :

1. Sadagopan .S, "ERP - A Managerial Perspective", TMH, New Delhi, 1999.
2. Christopher, "Logistics and Supply Management", Richard Irwin, 1994.
3. Ayers .J.B, Hand Book of "Supply Chain Management", The St. Lencie Press, 2000.
4. Steudel .H.J, and Desruelle .P, "Manufacturing in The Nintees - How to Become a Mean, Lean and World Class Competitor", Van Nostrand Reinhold, New York, 1992.
5. Nicolas .J.N, "Competitive Manufacturing Management - Continuous Improvement, Lean Production, Customer Focused Quality, McGraw-Hill, New York, 1998.
6. Scharj .P.B, Lasen .T.S, "Managing the Global Supply Chain", Viva Books, New Delhi, 2000.

ME	TOTAL QUALITY MANAGEMENT	3	0	0	3
1.	Concepts of TQM : Philosophy of TQM, Customer Focus, Organisation, Top Management Commitment, Teamwork, Quality Philosophies of Deming, Crosby and Muller.				12 0 0
2.	TQM Process : QC Tools, Problem Solving Methodologies, New Management Tools, Work Habits, Quality Circles, Bench Marking, Strategic Quality Planning.				12 0 0
3.	TQM Systems : Quality Policy Deployment, Quality Function Deployment, Standardisation, Designing for Quality, Manufacturing for Quality.				12 0 0
4.	Quality System : Need for ISO 9000 System, Advantages, Clauses of ISO 9000, Implementation of ISO 9000, Quality Costs, Quality Auditing, Case Studies, ISO 9001:2000 Quality Management System (QMS) – Manual – Implementation – IQA Certification Processes.				12 0 0
5.	Implementation of TQM : Steps, KAIZEN, 5S, JIT, POKAYOKE, Taguchi Methods, Case Studies. Total Productive Maintenance (TPM) : Philosophy and Implementation – Benchmarking – Type - Applications				12 0 0
					Total 60 hrs

References :

1. John Bank, "The Essence of Total Quality Management", PHI, 1993.
2. Rose, J.E, "Total Quality Management", Kogan Page Ltd. 1993.
3. Greg Bounds, Lyle Yorks et al, "Beyond Total Quality Management", McGraw Hill, 1994.
4. Takashi Osada, "The 5S", The Asian Productivity Organisation, 1991.
5. Masaki Imami, "KAIZEN:", McGraw Hill, 1986.
6. Seiichi Nakagima, "Introduction to Total Productive Maintenance", Productivity Press (India) Pvt. Ltd., 1993.

	RESEARCH METHODOLOGY	3	0	0	3
1.	Concepts and Importance of Research Methodology : Meaning of Research – Objectives – Types and Importance of Research – Research Process for Applied and Basic Research.				12 0 0
2.	Research Design : Need – Concepts related to Research Design – Different Research Designs – Meaning – Importance and Scale Construction Techniques.				12 0 0
3.	Sample Design and Data Collection : Criteria for Selecting a Good Sample Design – Random Sample – Sampling Techniques – Probabilistic and Non-probabilistic Samples – Sample Size – Collection of Data –				

Primary and Secondary Sources – Selection of Appropriate Methods – Guidelines for Questionnaire Design and Successful Interviewing.

12 0 0

4. Processing and Analysis of Data : Process Operations – Problems in Processing – Types of Analysis – Measures of Relationship – Factor –Cluster – Discriminate Analysis.

12 0 0

5. Hypothesis Testing and Research Report : Basic Concepts and Procedure – Report Writing – The Role of Computers in Research – Use of Internet.

12 0 0

Total 60 hrs

References :

1. Kothari C.R, "Research Methodology – Methods & Techniques", Wishwa Prakashan, A Division of New Age International Pvt. Ltd.
2. Donald R. Cooper and Ramela S. Schindler, "Business Research Methods", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2000.
3. Uma Sekaran, "Research Methods for Business", John Wiley & Sons Inc., New York, 2000.
4. Donald H. McBurney, "Research Methods", Thomson Asia Pvt. Ltd., Singapore.
5. Ranjit Kumar, "Research Methodology", Sage Publications, London, New Delhi, 1999.
6. Chandan J.S, Statistics for Business and Economics", Vikas Publishing House Pvt. Ltd., 1998.