**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M.TECH. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**EFFECTIVE FROM ACADEMIC YEAR 2019- 20 ADMITTED BATCH**

**R19 COURSE STRUCTURE AND SYLLABUS**

**I Year I Semester**

| Course Code | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|
| Professional Core - I | Advanced Computer Aided Design | 3 | 0 | 0 | 3 |
| Professional Core - II | Design for Manufacturing and Assembly | 3 | 0 | 0 | 3 |
| Professional Elective- I | 1. Optimization Techniques & Applications<br>2. MEMS & Micro Systems: Design & Manufacturing<br>3. Advanced Manufacturing Processes | 3 | 0 | 0 | 3 |
| Professional Elective-II | 1. Flexible Manufacturing Systems<br>2. Theory of Elasticity & Plasticity<br>3. Quality Engineering in Manufacturing | 3 | 0 | 0 | 3 |
| | Research Methodology & IPR | 2 | 0 | 0 | 2 |
| Lab - I | Advanced Computer Aided Design Lab | 0 | 0 | 4 | 2 |
| Lab - II | Advanced Casting & Welding Lab | 0 | 0 | 4 | 2 |
| Audit - I | Audit Course- I | 2 | 0 | 0 | 0 |
| | **Total** | **16** | **0** | **8** | **18** |

**I Year II Semester**

| Course Code | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|
| Professional Core - III | Design of Hydraulic & Pneumatic Systems | 3 | 0 | 0 | 3 |
| Professional Core - IV | Manufacturing Systems: Simulation Modelling & Analysis | 3 | 0 | 0 | 3 |
| Professional Elective- III | 1. Precision Engineering<br>2. Advanced Tool Design<br>3. Product Data Management | 3 | 0 | 0 | 3 |
| Professional Elective-IV | 1. Materials Technology<br>2. Vibration Analysis & Condition Monitoring<br>3. Fuzzy Logic & Neural Networks | 3 | 0 | 0 | 3 |
| | Mini Project with Seminar | 0 | 0 | 4 | 2 |
| Lab - III | Hydraulic & Pneumatics Lab | 0 | 0 | 4 | 2 |
| Lab - IV | Simulation of Manufacturing Systems Lab | 0 | 0 | 4 | 2 |
| Audit - II | Audit Course- II | 2 | 0 | 0 | 0 |
| | **Total** | **14** | **0** | **12** | **18** |

**II Year I Semester**

| Course Code | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|
| Professional Elective- V | 1. Advanced Finite Element and Boundary Element Methods<br>2. Smart Materials & Structures<br>3. Intelligent Manufacturing Systems | 3 | 0 | 0 | 3 |
| Open Elective | Open Elective | 3 | 0 | 0 | 3 |
| Dissertation | Dissertation Work Review - II | 0 | 0 | 12 | 6 |
| | **Total** | **6** | **0** | **12** | **12** |

**II YEAR II - SEMESTER**

| Course Code | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|
| Dissertation | Dissertation Work Review - III | 0 | 0 | 12 | 6 |
| Dissertation | Dissertation Viva-Voce | 0 | 0 | 28 | 14 |
| | **Total** | **0** | **0** | **40** | **20** |

***For Dissertation Work Review - I, Please refer 7.8 in R19 Academic Regulations.**

**Audit Course I & II:**

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills

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**ADVANCED COMPUTER AIDED DESIGN (Professional Core - I)**

**UNIT I:**
**Principles of Computer Graphics :** Introduction, graphic primitives, point plotting, lines, Bresenham's circle algorithm, ellipse, transformation in graphics, coordinate systems, view port, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of characters.

**UNIT II:**
**Cad Tools:** Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software.
**Geometric modelling:** Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves B-splines rational curves.

**UNIT III:**
**Surface Modeling: Mathematical** representation surfaces, Surface model, Surface entities surface representation, parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.

**UNIT IV:**
**Parametric Representation of Synthetic Surfaces:** Hermite Bicubic surface, **Bezier** surface, **B-**Spline surface, COONs surface, Blending surface Sculptured surface, Surface manipulation — Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).

**UNIT V:**
**Geometricmodelling-3D:** Solid modeling, Solid Representation, Boundary Representation (13-rep), Constructive Solid Geometry (CSG).
**CAD/CAM Exchange**: Evaluation of data -exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF. Design Applications: Mechanical tolerances, Mass property calculations, Finite Element Modeling and Analysis and Mechanical Assembly.
**Collaborative Engineering:** Collaborative Design, Principles, Approaches, Tools, Design Systems.

**TEXT BOOKS:**
1. CAD/CAM Concepts and Applications/ Alavala/ PHI
2. CAD/CAM /Groover M.P./ Pearson education
3. Mastering CAD/CAM / Ibrhim Zeid / McGraw Hill International.
4. CAD/CAM Principles and Applications/ P.N. Rao/TMH/3rd Edition

**REFERENCES:**
1. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
2. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson
3. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.

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**DESIGN FOR MANUFACTURING AND ASSEMBLY (Professional Core - II)**

**Prerequisites:** Manufacturing Processes, Engineering Materials

**Course Objectives**: The objective of course is identify the manufacturing constraints that influence the design of parts and part systems. Students will be introduced to the Design for Manufacturability (DFM) methodology, and will be motivated to understand infeasible or impractical designs.

**Course Outcomes:** At the end of the course, the student will be able to:

- Understand the quality aspects of design for manufacture and assembly
- Apply Boothroyd method of DFM for product design and assembly
- Apply the concept of DFM for casting, welding, forming and assembly
- Identify the design factors and processes as per customer specifications
- Apply the DFM method for a given product

**UNIT - I:**

**Introduction:** Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of design Ling for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection - Material selection interrelationship with process selection process selection charts.

**UNIT - II:**

**Machining Process**: Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts. **Metal Casting**: Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting.

**UNIT - III:**

**Metal Joining**: Appraisal of various welding processes, Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of dies drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking.
**Plastics**: Viscoelastic and Creep behavior in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding.

**UNIT-IV**

**Assemble Advantages:** Development of the assemble process, choice of assemble method assemble advantages social effects of automation.
**Automatic Assembly Transfer Systems**: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

**UNIT-V:**

**Design of Manual Assembly**: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and

fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

**TEXT BOOKS:**

1. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
2. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.
3. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.

**REFERENCES:**

1. Computer Aided Assembly London/ A Delbainbre/.
2. Product Design for Manufacturing and Assembly/ Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight/CRC Press/2010

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**M. TECH. I Year I Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**OPTIMIZATION TECHNIQUES AND APPLICATIONS (Professional Elective - I)**

**Pre-requisites**: Operations Research

**Course Objectives:** The main objectives of the course are: Learn

- Numerical optimization techniques for single variable and multi variable non- linear optimization problems.
- Sensitivity analysis on LPP queuing
- Simulation of annexing problem & inventory problem.
- Geometry cutting plane method & branch bound method for linear IPP.
- Meaning of stochastic programming problem simple problems for finding mean variance of random variables chance constrained algorithm.
- Formulation of GP model and solving it using arithmetic geometric inequality theorem.
- State of art nontraditional optimization technique, namely genetic algorithm simulated annealing & particle swarm optimization.

**Course Outcomes:** At the end of the course, the student is able to apply appropriate optimization techniques and solve.

- Based on the type of optimization problem like single variable or multivariable,
- Make sensitivity analysis to study effect of changes in parameters of LPP on the optimal solution without reworking.
- Simulate the system to estimate specified performance measures.
- Solve integer programming problem by either geometry cutting plane algorithm or branch band method.
- Apply chance constrained algorithm and solve stochastic linear programme.
- Formulate GP model and solve it.
- Solve given optimization problem by genetic algorithm or simulated annealing or PSO.

**UNIT-I:**
**Single Variable Non-Linear Unconstrained Optimization:** Elimination methods: Uni-Model function-its importance, Fibonacci method & Golden section method. Interpolation methods: Quadratic & Cubic interpolation methods.

**UNIT-II:**
**Multi variable non-linear unconstrained optimization:** Direct search methods – Univariant method, Pattern search methods – Powell's, Hook -Jeeves, Rosenbrock search methods. Gradient methods: Gradient of function& its importance, Steepest descent method, Conjugate direction methods: Fletcher-Reeves method & variable metric method.

**UNIT-III:**
**Linear Programming:** Formulation, Simplex method & Artificial variable optimization techniques: Big M & Two-phase methods. Sensitivity analysis: Changes in the objective coefficients, constants& coefficients of the constraints. Addition of variables, constraints. Simulation – Introduction – Types-steps – applications: inventory & queuing – Advantages and disadvantages.

**UNIT-IV:**
**Integer Programming:** Introduction – formulation – Geometry cutting plane algorithm – Zero or one algorithm, branch and bound method

**Stochastic Programming**: Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution. Stochastic linear programming: Chance constrained algorithm.

**UNIT-V:**

**Geometric Programming:** Posynomials – Arithmetic - Geometric inequality – unconstrained G.P-constrained G.P (≤ type only)

**Non-Traditional Optimization Algorithms:** Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm & Traditional Methods. Simulated Annealing-Working Principle-Simple Problems. Introduction to Particle Swarm Optimization (PSO) (very brief)

**TEXT BOOKS:**

1. Optimization theory & Applications by S. S. Rao, New Age International.
2. Optimization for Engineering Design by Kalyanmoy Deb, PHI

**REFERENCE BOOKS:**

1. Operations Research by S. D. Sharma
2. Operation Research by H. A. Taha, TMH
3. Optimization in operations research by R. L Rardin
4. Optimization Techniques by Benugundu & Chandraputla, Pearson Asia.
5. Optimization Techniques theory and practice by M. C. Joshi, K. M. Moudgalya, Narosa Publications.

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**MEMS & MICRO SYSTEMS: DESIGN & MANUFACTURING (Professional Elective - I)**

**UNIT – I:**

**Overview and Working Principles of Mems and Microsystems:** MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics.

**UNIT – II:**

**Engineering Science for Microsystems Design and Fabrication:** Atomic structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics

**UNIT – III:**

**Engineering Mechanics for Microsystems Design:** Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics Fracture Mechanics, Thin-Film Mechanics, Overview of Finite Element Stress Analysis

**UNIT – IV:**

**Thermo Fluid Engineering & Microsystems Design:** Overview of Basis of Fluid Mechanics in Macro and Mesoscales, Basic equations in Continuum Fluid Dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid Flow in Sub micrometer and Nanoscale, Overview of Heat conduction in Solids, Heat conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical Design using FEM, Design of a Silicon Die for a Micro pressure Sensor

**UNIT – V:**

**Materials for Mems & Microsystems and Their Fabrication:** Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon Compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, Chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process.

**REFERENCES:**

1. Tai – Ram Hsu, MEMS & Microsystems: Design & Manufacturing, Tata Mc-Graw Hill,ed., 2002
2. Maluf, M., “An Introduction to Microelectromechanical Systems Engineering”, Artech House, Boston, 2000
3. Trimmer, W.S.N., “Micro robots and Micromechanical Systems”, Sensors & Actuators, vol. 19, no.1989.
4. Trim, D.W., “Applied Partial Differential Equations”, PWS-Kent Publishing, Boston, 1990.
5. Madou, M., “Fundamentals of Microfabrication”, CRC Press, Boca Raton, 1997.
6. Hsu, T.R., “The Finite Element Method in Thermomechanics”, Alien & Unwin, London, 1986.

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**M. TECH. I Year I Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**ADVANCED MANUFACTURING PROCESSES (Professional Elective - I)**

**Prerequisites:** Production Technology, Machine Tools, Metal Cutting, Material Science.

**Course Objectives:**

- To make acquainted the various unconventional manufacturing processes
- To know about the applications of advanced manufacturing processes (which are exceptional)
- To encourage the students for developing the models of Advanced Manufacturing Processes

**Course Outcomes:**

- At the end of the course, the student will be able to understand the working principle of Electron beam, laser beam and laser beam processes.
- Able to understand different types of composite material characteristics, types of micro & macro machining processes.
- Understand the e-manufacturing & nano materials.

**UNIT-I:**

Surface treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

**UNIT-II:**

Non-Traditional Machining: Introduction, need, AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment, process characteristics, performance, EDM – principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, WEDM.

**UNIT-III:**

Laser Beam Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

**UNIT-IV:**

Processing of ceramics: Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics.
Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

**UNIT-V:**

Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics.

E-Manufacturing, nanotechnology, micromachining and High-speed Machining, basic principles, working, applications, advantages.

**TEXT BOOKS:**

1. Manufacturing Engineering and Technology by Kalpakijian, Adisson Wesley, 1995.
2. Foundation of MEMS by Chang Liu, Pearson, 2012.
3. Advanced Machining Processes by V.K.Jain, Allied Publications.

**REFERENCE BOOKS:**

1. Process and Materials of Manufacturing by R. A. Lindburg, 4th edition, PHI 1990.
2. Introduction to Manufacturing Processes by John A Schey, Mc Graw Hill.
3. Micro Machining of Engineering Materials by J.Mc Geough, CRC Press.
4. Non-Traditional Manufacturing Processes by Gary F Benedict, CRC Press.
5. Advanced Methods of Machining by J.A Mc Geough, Springer.

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**FLEXIBLE MANUFACTURING SYSTEMS (Professional Elective - II)**

**Prerequisites**: Machine Tools, Basics of Industrial Engineering

**Course Objectives**:

- To Understand the role of Flexible Manufacturing Systems (FMS) in manufacturing
- To Understand the concept of Group Technology
- To Understand the concept of Cellular Mfg Systems
- To Understand the benefits of automation
- To Know types of manufacturing industries
- To have a basic knowledge of automation equipment
- To Understand logic control and associated technologies

**Course Outcomes**: At the end of the course, the student shall be able to:

- Develop FMS using the most appropriate technique.
- Implement FMS concept in a manufacturing environment
- Use various types of sensors and actuators in PLC implementations
- Explain the role of automation in manufacturing
- Tell the difference between Group Technology and Cellular Manufacturing
- Classify automation equipment and assembly systems into different categories.

**UNIT-I:**
**Understanding of FMS**: Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications Flexibility in Pull and Push type

**UNIT-II:**
**Classification of FMS Layout**: Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc.

**UNIT-III:**
**Processing stations**: Salient features Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/Deburring station

**UNIT-IV:**
**Material Handling System**: An introduction, Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS) Management technology: Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS

**UNIT-V:**
Design of FMS: Performance Evaluation of FMS, Analytical model and Simulation model of FMS Case studies: Typical FMS problems from research papers

**TEXT BOOKS:**

1. Flexible Manufacturing Cells and System by William W Luggen, Prentice Hall of Inc New Jersey, 1991
2. Flexible Manufacturing system by Reza A Maleki, Prentice Hall of Inc New Jersey, 1991
3. Flexible Manufacturing by John E Lenz, marcel Dekker Inc New York ,1989.

**REFERENCE BOOK:**

1. Automation, Production Systems and Computer Integrated Manufacturing by Groover, M.P, Prentice Hall.

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**THEORY OF ELASTICITY & PLASTICITY (Professional Elective - II)**

**UNIT – I:**
**Elasticity:** Two-dimensional stress analysis - Plane stress - Plane strain - Equations of compatibility - Stress function - Boundary conditions.
**Problem in Rectangular Coordinates** - Solution by polynomials - Saint Venent's principles - Determination of displacement - Simple beam problems.
**Problems in Polar Coordinates** - General equations in polar coordinates - Stress distribution symmetrical about axis - Strain components in polar coordinates - Simple and symmetric problems.

**UNIT – II:**
**Analysis of Stress and Strain in Three Dimensions**: Principle stresses - Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain.
**General theorems**: Differential equations of equilibrium and compatibility - Displacement - Uniqueness of solution - Reciprocal theorem.

**UNIT - III:**
**Bending of Prismatic Bars:** Stress function - Bending of cantilever beam - Beam of rectangular cross-section - Beams of circular cross-section.

**UNIT – IV:**
**Plasticity**: Plastic deformation of metals - Structure of metals - Deformation - Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity.

**UNIT – V:**
**Methods of Solving Practical Problems:** The characteristic method - Engineering method - Compression of metal under press - Theoretical and experimental data drawing.

**REFERENCES:**
1. Theory of Elasticity/Timoshenko S.P. and Goodier J.N./Koakusha Publishers
2. An Engineering Theory of Plasticity/E.P. Unksov/Butterworths
3. Applied Elasticity/W.T. Wang/TMH
4. Theory of Plasticity for Engineers/Hoffman and Sacks/TMH
5. Theory of Elasticity and Plasticity/Sadhu Singh/ Khanna Publishers
6. Theory of Elasticity and Plasticity/Harold Malcolm Westergaard/Harvard University Press

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**QUALITY ENGINEERING IN MANUFACTURING (Professional Elective - II)**

**UNIT-I:**

**Quality Value and Engineering**: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances. (N-type, S-type and L-type)

**UNIT-II:**

**Tolerance Design and Tolerancing:** Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation fbr multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

**UNIT-III:**

**Analysis of Variance (ANOVA**): NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

**UNIT-IV:**

**Orthogonal Arrays**: Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

**UNIT-V:**

ISO-9000 Quality System, BDRE, 6.-sigma, Bench marking, Quality circles Brain Storming — Fishbone diagram — problem analysis.

**REFERENCES:**

1. Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill, Intl. II Edition, 1995
2. Quality Engineering in Production systems **/** G. Taguchi, A. Elsayed et al **/** McGraw Hill Intl. Edition, 1989**.**
3. Taguchi Methods explained: Practical steps to Robust Design **/** Papan P. Bagchi**/** Prentice Hall md. Pvt. Ltd., New Delhi.

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## RESEARCH METHODOLOGY AND IPR

**Prerequisite:** None

**Course Objectives:**

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

**Course Outcomes:** At the end of this course, students will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**UNIT-I:**
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**UNIT-II:**
Effective literature studies approaches, analysis, Plagiarism, Research ethics

**UNIT-III:**
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**UNIT-IV:**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**UNIT-V:**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**TEXT BOOKS:**

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

**REFERENCES:**

1. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Asimov, “Introduction to Design”, Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
7. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

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## ADVANCED COMPUTER AIDED DESIGN LAB (Lab - I)

**Note:** Conduct any Ten exercises from the list given below:

1. Two- dimensional drawing using CAD software.
2. Three-dimensional drawing using CAD software.
3. Various Dimensioning and tolerancing techniques on typical products using CAD software.
4. Assembly and animation of simple assemblies like screw jack, bolt-nut mechanism, etc.
5. Truss analysis using FEA software.
6. Beam analysis using FEA software.
7. Frame analysis using FEA software.
8. Buckling analysis of columns using FEA software.
9. Harmonic analysis using FEA software.
10. Fracture analysis using FEA software.
11. Analysis of laminated composites using FEA software.
12. Couple-field analysis using FEA software.
13. Modal Analysis
14. Transient dynamic analysis.
15. Spectrum analysis.

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## ADVANCED CASTING & WELDING LAB (Lab - II)

**List of Experiments:**

1. Tensile Strength Evaluation of TIG Welded Specimens under variable conditions.
2. Hardness Evaluation of TIG Welded Specimens under variable conditions.
3. Tensile Strength Evaluation of MIG Welded Specimens under variable conditions.
4. Hardness Evaluation of MIG Welded Specimens under variable conditions.
5. Inclusion Analysis of Cast Specimens
6. Size Analysis of Grains for Cast Specimens under different input variables
7. Design of Runner & Riser
8. Non-Destructive Testing of Welded Joint
9. Study of Blow Moulding
10. Study of Injection Moulding

**Note**: Each experiment involves preparation of Joint/ Casting, specimen preparation, testing, evaluation and reporting may be chosen from the above list.

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**DESIGN OF HYDRAULIC & PNEUMATIC SYSTEMS (Professional Core - III)**

**UNIT – I:**
Oil hydraulic systems Hydraulic pumps, types and construction details, sizing and selection.
Direction control valves, flow and pressure control valves.

**UNIT – II:**
Linear actuators types Piston rod design sizing and selection, Rotary actuators, hydraulic reservoir accumulators.

**UNIT – III:**
Design of hydraulic circuits, seals and packings, hydraulic servo techniques, cylinders and air motors.

**UNIT – IV:**
Sequencing and synchronizing circuits, accumulator, low cost automation Hydro circuits, accumulators, Hydro pneumatic circuits principles of pneumatic circuit design.

**UNIT – V:**
Maintenance and trouble shooting of hydraulic and pneumatic circuits, components,
PLC Automation and uses of Microprocessors.

**REFERENCES:**
1. Oil Hydraulic Systems/ S.R. Majumdar/ Tata McGraw Hill
2. Pneumatic systems, principles and maintenance/ S.R. Majumdar/Tata McGraw Hill
3. Hydraulic and pneumatics/ Andrew Darr/ Jaico Publishing Hoise.
4. Fluid power with applications/ Antony Esponssito/ Prentice Hall

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**MANUFACTURING SYSTEMS: SIMULATION MODELLING & ANALYSIS (Professional Core - IV)**

**Prerequisites:** Operations Research, Optimization Techniques and Applications and Probability Statistics

**Course Objectives**:
- Learn way of analyzing the systems.
- Classification of systems based nature of dynamics and knowledge of elements.
- To develop simulation model for dynamic discrete – event stochastic system.
- To run the model and collect the data.
- To analyze the output data of simulation for specified for performance measures bases on type of simulation and method of output data analysis.

**Course Outcomes**: At the end of course, student should able to
- Define the state of system W.R.T specified performance measures.
- Identify Dynamic Discrete- event stochastic system.
- Develop simulation model for the said system
- Analyze the model and present the results to specified confidence level.

**UNIT - I:**
System – ways to analyze the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors – Framing – strong law of large numbers.

**UNIT - II:**
Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

**UNIT - III:**
Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – weibull – normal Bernoullie – Binomial – uniform – poison. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.

**UNIT - IV:**
Output data analysis – Types of Simulation with respect to output data analysis – warm up period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons

**UNIT –V:**
Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – New boy paper problem.

**TEXT BOOKS:**

1. Simulation Modelling and Analysis by Law, A.M. & Kelton, McGraw Hill, 2nd Edition, New York, 1991.
2. Discrete Event System Simulation by Banks J. & Carson J.S., PH, Englewood Cliffs, NJ, 1984.

**REFERENCE BOOKS:**

1. Simulation of Manufacturing Systems by Carrie A., Wiley, NY, 1990.
2. A Course in Simulation by Ross, S.M., McMillan, NY, 1990.
3. Simulation Modelling and SIMNET by Taha H.A., PH, Englewood Cliffs, NJ, 1987.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**PRECISION ENGINEERING (Professional Elective - III)**

**Pre-requisites:** Machine Tools, Metrology

**Course Objectives:**

- To give the basic precision engineering methodology and state-of-the-art concepts for designing high-precision CNC machines and products.
- The course is specifically tailored to teach the novel design principles leading to improved machine performance and reliability.
- To apply the acquired knowledge to other design efforts and fields as well

Course Outcomes: At the end of the course, the student will be able to:

- Apply fits and tolerances for parts and assemblies according to ISO standards.
- Apply selective assembly concept for quality and economic production.
- Assign tolerances using principles of dimensional chains for individual features of a part or assembly.
- Evaluate the part and machine tool accuracies.
- Analyze the causes for dimensional and geometrical errors prior to and during machining and suggest remedies

**UNIT- I:**

**Concepts of Accuracy:** Introduction – Concept of Accuracy of Machine Tools – Spindle and Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity Lags.

**Geometric Dimensioning and Tolerance:** Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datum –Datum Feature of Representation – Form Controls, Orientation Controls – Logical Approach to Tolerance.

**UNIT-II:**

**Datum Systems:** Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

**UNIT-III:**

Tolerance Analysis: Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, $C_p$, $C_{pk}$, Cost aspects, Feature Tolerances, Geometric Tolerances.

**Tolerance Charting Techniques**: Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and central analysis, Examples. Design features to facilitate machining; Datum Features – functional and manufacturing. Components design – Machining considerations, Redesign for manufactured parts examples

**UNIT–IV:**

Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

**UNIT-V:**

**Measuring Systems Processing**: In process or in-situ measurement of position of processing point-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems.

**TEXT BOOKS:**

1. Precision Engineering in Manufacturing by Murthy R. L., New Age International (P) limited, 1996.
2. Geometric Dimensioning and Tolerancing by James D. Meadows, Marcel Dekker Inc. 1995.

**REFERENCE BOOK:**

1. Engineering Design – A systematic Approach by Matousek, Blackie & Son Ltd, London.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**ADVANCED TOOL DESIGN (Professional Elective - III)**

**Prerequisite:** Production technology

**Course Outcomes:** At the end of the course the students will be able to

- Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools apply the design procedures for different types of design problems such as gear box design, guide way
- Design, shaft loading and its associated parts, rolling bearings, die design and jigs and fixtures and so on.

**UNIT – I:**
**Tool Materials:**
Prosperities of materials: Tools steels, Cast Iron, Mild or low carbon steels, Non metallic and nonferrous materials, Heat treating

**UNIT – II:**
**Design of Cutting Tools:**
Single Point cutting tools: Milling cutters, Drills, Selection of carbide steels – Determination of shank size for single point carbide tools, Determining the insert thickness for carbide tools

**UNIT – III:**
**Design of Jigs and Fixtures:**
Basic principles of location and clamping: Locating methods and devices, Jigs-Definition Types, General considerations in the design of Drill jigs, Drill bushing, Methods of Construction. Fixtures-Vice fixtures, Milling, Boring Lathe Grinding fixtures.

**UNIT – IV:**
**Design of Sheet Metal Blanking and Piercing Dies:**
Fundamentals of Die cutting operation, Power press types, General press information, Materials Handling equipment. Cutting action in Punch and die operations. Die clearance, Types of Die construction. Die design fundamentals-Banking and piercing die construction, pilots, stripper and pressure pads presswork material, Strip layout, Short run tooling for piercing.

**UNIT – V:**
**Design of Sheet Metal Bending, Forming and Drawing Dies:**
Bending dies, drawing dies, forming dies, drawing operations, Variables that effect metal flow during drawing. Determination of blank size, Drawing force, Single, and double action draw dies.

**TEXT BOOKS:**

1. Donaldson “Tool Design”/ Tata McGraw Hill
2. Production Technology/HMT/Tata McGraw Hill/

**REFERENCES:**

1. Production Technology by R.K. Jain and S.C. Gupta.
2. Mechanical Metallurgy/ George F Dieter/ Tata McGraw Hill
3. Machine Tools/C Elanchezhian & M. Vijayan/Anuradha Publications
4. Principles of Machine Tools, Bhattacharya A and Sen. G. C. New Central Book Agency.
1. Hand Book of Metal forming/ Kurt Lange/ Mc Graw-Hill, 1987.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**PRODUCT DATA MANAGEMENT (Professional Elective - III)**

**UNIT - I:**
Introduction-Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behavior analysis. Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

**UNIT - II:**
**Concept Generation and Selection:** Task – Structured approaches – Clarification – Search – Externally and internally – explore systematically – reflect on the solutions and process – concept selection – methodology – benefits.
**Product Architecture**: Implications – Product change – variety – component standardization – product performance – manufacturability.

**UNIT - III:**
**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.
**Industrial Design**: Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – simulating product performance and manufacturing processing electronically – Need for industrial design – impact – design process.

**UNIT - IV:**
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:** Definition – Estimation of manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity. Prototype basics – Principles of prototyping – planning for prototypes – Economics analysis – Understanding and representing tasks – baseline project planning – accelerating the project execution.

**REFERENCES:**
1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger / McGraw Hill International Edns. 1999.
2. Concurrent Engg/integrated Product development / Kemnneth Crow / DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book.
3. Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.
4. Tool Design–Integrated Methods for Successful Product Engineering / Staurt Pugh / Addsion Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41369-5.
5. Production and Operations Management/Chase/TMH

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

## MATERIALS TECHNOLOGY (Professional Elective - IV)

**Prerequisites: Mechanics of soilds**

**Course Outcomes:** At the end of the course, the student is able

- To understand on elastic, plastic and fractured behaviour of engineering materials.
- To do appropriate selection of metallic and non-metallic materials for the various engineering applications.

**UNIT - I:**
Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non crystalline material

**UNIT - II:**
Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

**UNIT - III:**
Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

**UNIT - IV:**
Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep. Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto , Marine, Machinery and Nuclear Applications.

**UNIT - V:**
**Modern Metallic Materials**: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides, Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials.
**Nonmetallic Materials**: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, $A1_2$ $O_3$, SiC, $Si_3N_4$, CBN and Diamond – properties, Processing and applications.

**TEXT BOOKS:**

1. Mechanical Behavior of Materials/Thomas H. Courtney/ McGraw Hill/2nd Edition/2000
2. Mechanical Metallurgy/George E. Dicter/McGraw Hill, 1998.

**REFERENCES:**

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2. Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson
3. Material Science and Engineering/William D Callister/John Wiley and Sons.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**VIBRATION ANALYSIS & CONDITION MONITORING (Professional Elective - IV)**

**Course Outcomes:** At the end of the course the students will be able to

- To study the vibrations in machine elements and how to control them.
- Ability to analyze the mathematical model of linear vibratory system to determine its response
- Obtain linear mathematical models of real life engineering systems
- Determine vibratory responses of single and multi degree of freedom systems to harmonic, periodic and non-periodic excitation

**UNIT – I:**
Causes and effects of vibration, Vibration of single Degree and Multi Degree of freedom systems. Steady state and transient characteristics of Vibration.

**UNIT – II:**
Introduction to Condition Monitoring, Failures types, investigation and occurrences. Causes of failure, Characteristics of vibration ~SHM, Periodic motion, Displacement, Velocity and acceleration. Peak to peak & RMS, Linear and logarithmic scales and phase angle.

**UNIT – III:**
Vibration measuring instruments, vibration transducers, signal conditioning elements. Display and recording elements. Vibration meters and analyzers.

**UNIT – IV:**
Condition monitoring through vibration analysis. Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards. Contaminant analysis, SOAP and other contaminant monitoring techniques,

**UNIT – V:**
Special vibration measuring techniques Change in sound method, Ultrasonic measurement method, Shock pulse measurement, Kurtosis, Acoustic emission monitoring, Cepstrum analysis, Modal analysis, critical speed analysis, shaft -orbit & position analysis.

**Text Books:**

1. Mechanical Fault Diagnosis and Condition Monitoring/ Collacott. R.A./ Chapman & Hall, London, 1982
2. Vibration Measurement and Analysis/ Nakra. B. C. Yadava, G. S. and Thuested .L./ National Productivity Council, New Delhi, 1989.

**REFERENCES:**

1. Theory of vibrations with applications by W.T. Thompson, Pearson publications.
2. Mechanical Vibrations by SS Rao, PHI Publications

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**FUZZY LOGIC & NEURAL NETWORKS (Professional Elective - IV)**

**UNIT- I**

**Fuzzy Set Theory and Fuzzy Logic Control:** Basic concepts of fuzzy sets- Operations on fuzzy sets- Fuzzy relation equations- Fuzzy logic control- Fuzzification –Defuzzificatiuon- Knowledge base- Decision making logic- Membership functions – Rule base.

**UNIT- II**

**Adaptive Fuzzy Systems**: Performance index- Modification of rule base0- Modification of membership functions- Simultaneous modification of rule base and membership functions- Genetic Algorithms-Adaptive fuzzy system- Neuro fuzzy systems.

**UNIT- III**

**Artificial Neural Networks:** Introduction- History of neural networks- multilayer perceptions- Back propagation algorithm and its Variants- Different types of learning, examples.

**UNIT- IV**

**Mapping and Recurrent Networks:** Counter propagation –Self organization Map- Congnitron and Neocognitron- Hopfield Net- Kohonnen Nets- Grossberg Nets- Art-I, Art-II reinforcement learning

**UNIT- V**

**Case Studies:** Application of fuzzy logic and neural networks to Measurement- Control- Adaptive Neural Controllers – Signal Processing and Image Processing

**TEXT BOOK:**

1. Vallum B. R And Hayagriva V.R C++, Neural networks and Fuzzy logic, BPB Publications, New Delhi, 1996

**REFERENCE BOOKS:**

1. Fuzzy logic &Neural Networks/ Chennakesava R. Alavala/ New Age International, 2008
2. Neural Networks for control, Millon W. T, Sutton R.S and Werbos P.J, MIT Press 1992
3. Fuzzy sets Fuzzy logic, Klir, G.J anfd Yuan B.B Prentice Hall of India Pvt. Ltd.,, New Delhi
4. Neural Networks and Fuzzy systems, Kosko.. Prentice hall of India Pvt. Ltd.,, New Delhi 1994
5. Introduction to Fuzzy control, Dirankov D. Hellendoorn H, Reinfrank M., Narosa Publications House, New Delhi 1996.
6. Introduction to Artificial Neural systems, Zurada J. M Jaico Publishing House, New Delhi 1994

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**HYDRAULIC & PNUEMATICS LAB (Lab – III)**

**Note: Any TEN of the Following Experiments**

**LIST OF EXPERIMENTS**

1. Study of Pressure relief valve and Directional Control valves in Hydraulic System.
2. Draw the Circuit diagram to operate Double Acting Hydraulic Cylinder using 4/3 Direction Control Valve (Manual type).
3. Draw the Circuit diagram to operate Double Acting Hydraulic Cylinder using 4/2 Direction Control Valve (Single Solenoid) using Push button momentary switch/using Latch Switch.
4. Draw the Circuit diagram to operate Double Acting Hydraulic Cylinder using 4/2 Direction Control Valve (Solenoid Control) using Push button switch for varying flow rate using flow control valve/using Latch for varying flow rate using flow control valve.
5. Simulation of Double Acting Hydraulic Cylinder using 4/2 Direction Control Valve (manual control) using simulation software.
6. Simulation of Double Acting Hydraulic Cylinder using 4/2 Direction Control Valve using Push button with spring return valve.
7. Study of pneumatic components:
    i. Air compressor along with air receiver tank
    ii. FRL unit
    iii. Control valves
8. Draw the Circuit diagram to operate a Single Acting Pneumatic Cylinder using 3/2 Push Button Direction Control Valve (Manual).
9. Draw the circuit diagram to operate Double Acting Pneumatic Cylinder using 5/2 Direction Control Valve (solenoid) and Push button momentary switch/Latch Switch.
10. Draw the circuit diagram for speed control of single & Double Acting Pneumatic Cylinder.
11. Simulation of Single Acting Pneumatic Cylinder using 3/2 Push Button Direction Control Valve using Simulation software.
12. Simulation of Double Acting Pneumatic Cylinder using 5/2 Push Button Direction Control Valve using Simulation software.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. I Year II Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**SIMULATION OF MANUFACTURING SYSTEMS LAB (Lab – IV)**

**A. MANUFACTURING SIMULATION**

The students will be given training on the use and application of the following software to manufacturing problems:

1. Auto MOD Software.
2. PROMODEL
3. SLAM-II
4. CAFIMS
5. Flexsim

They also learn how to write sub routines in C-language and interlinking with the above packages.
Problems for modelling and simulation experiments:

1. AGV planning
2. ASRS simulation and performance evaluation
3. Machines, AGVs and AS/RS integrated problems
4. JIT system
5. Kanban flow
6. Material handling systems
7. M.R.P. Problems
8. Shop floor scheduling etc.

**B. PRECISION ENGINEERING**

1. Hydraulic and Pneumatic circuits
2. Closed loop control systems
3. Study of the chip formation in turning process
4. Study of operation of tool and cutter grinder, twist drill grinder, Centreless grinder
5. Determination of cutting forces in turning
6. Experiments in unconventional manufacturing processes-AJM and study of USM, EDM, Laser Machining and Plasma spraying
7. Inspection of parts using tool makers microscope, roughness and form tester
8. Study of micro-controllers, programming on various CNC machine tools and also controllers
9. Studies on PLC programming
10. Study and programming of robots
11. Condition monitoring in machining process using acoustic emission.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. II Year I Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**ADVANCED FINITE ELEMENT AND BOUNDARY ELEMENT METHODS**
**(Professional Elective - V)**

**Prerequisite:** Strength of Materials, Mathematics, Heat Transfer and Vibrations.
**Course Objectives**:

- To Introduce the basic concepts of the finite element method, the boundary element method
- To discuss the advantages and limitations of each method
- To Demonstrate the capabilities of each method on a variety of problems

**Course outcomes**: After completing this course, the student should be able to

- Understand the background of mathematical equations used for development of modeling software modules to develop the various structural related applications
- Identify mathematical model for solution of common engineering problems.
- Solve structural, thermal, fluid flow problems.
- Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.

**UNIT–I:**
**One Dimensional Problems**: Formulation of Stiffness Matrix for a Bar Element by the Principle of Minimum Potential Energy, Properties of Stiffness Matrix, Characteristics of Shape Functions, Quadratic shape functions.
**Analysis of Trusses:** Derivation of Stiffness Matrix for Trusses, Stress and strain Calculations, Calculation of reaction forces and displacements.
**Analysis of Beams:** Derivation of Stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection, Stresses, Shear force and Bending moment, Problems on uniform and stepped beams for different types of loads applied on beams.

**UNIT–II:**
**Finite element – formulation of 2D Problems:** Derivation of Element stiffness matrix for two-dimensional CST Element, Derivation of shape functions for CST Element, Elasticity Equations, constitutive matrix formulation, Formulation of Gradient matrix. Two dimensional Isoparametric Elements and Numerical integration.
**Finite element – formulation of 3D problems:** Derivation of Element stiffness matrix for
Tetrahedron Element, Properties of Shape functions for 3D Tetrahedral Element, Stress-Strain Analysis for 3D Element, Strain Displacement for Relationship Formulation.

**UNIT–III:**
**Steady state heat transfer analysis**: One Dimensional Finite Element analysis of fin and composite slabs. **Two-dimensional steady state heat transfer problems:** Derivation of Thermal Stiffness matrix for 2D heat transfer problems-CST, Derivation of thermal force vector for 2D heat transfer problems.
**Dynamic Analysis**: Formulation of mass matrices for uniform bar and beam Elements using lumped and consistent mass methods, Evaluation of Eigen values and Eigen vectors for a stepped bar and beam Problems.

**UNIT–IV:**
**Plate Bending**: Introduction – Plate behavior – $C^1$ (Kirchoff) Plate elements – $C^0$ (Mindlin) Plate elements – Mindlin beam – More devices for $C^0$ Plate elements – Boundary conditions - Analytical problems.

**Nonlinear finite element of solids**: Material Nonlinearities, objective rates, nonlinear elasticity, Plasticity, viscoplasticity, viscoelasticity

**UNIT–V:**

**Boundary Element Method: Potential Problems:** Introduction, boundary Element Approach-Fundamental solution. Numerical Implementation - Determination of Ci, Final Relation, Three-dimensional analysis, tackling kernel singularity.

**Boundary Element Formulation for Electrostatic Problems:** Introduction, Basic Relation-Boundary condition, other relations. Discretization and Matrix Formulation – Determination of term $C(p)_m$.

**Text Books**:

1. Finite and Boundary Element Methods in Engineering by O.P. Gupta, Oxford & IBH Publishing Co. Pvt. Ltd
2. The finite element methods in Engineering by S.S. Rao, Elsevier, 4th edition

**Reference Books:**

1. Finite Element Methods by Alavala, PHI.
2. Introduction to Finite Elements in Engineering by Tirupathi K. Chandrupatla and Ashok D. Belagundu.
3. An Introduction to Finite Element Methods by J. N. Reddy, Mc Grawhill
4. The Finite element method in engineering science by O.C. Zienkowitz, Mc Graw hill.
5. Concepts and Applications of Finite Element Analysis by Robert Cook, Wiley

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. II Year I Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**SMART MATERIALS & STRUCTURES (Professional Elective - V)**

**UNIT - I**
Overview of Smart Materials, Structures and Products Technologies.

**UNIT - II**
Smart materials (Physical Properties) Piezoelectric Materials, Elecrostrictive Materials, Magnetostrictive Materials, Magneto electric Materials. Magnetorheological Fluids, Electroheological Fluids, Shape Memory Materials, Fiber-Optic Sensors.

**UNIT - III**
**Smart Sensor, Actuator and Transducer Technologies:** Smart Sensors: Accelerometers; Force Sensors; Load Cells; Torque Sensors; Pressure Sensors; Microphones; Impact Hammers; MEMS Sensors; Sensor Arrays Smart Actuators; Displacement Actuators; Force Actuators; Power Actuators: Vibration Dampers; Shakers; Fluidic Pumps; Motors ; smart Transducers: Ultrasonic Transducers; Sonic Transducers.

**UNIT- IV**
**Measurement, Signal Processing, Drive and Control Techniques:** Quasi -static and Dynamic Measurement Methods; Signal conditioning devices; Constant voltage, Constant-current and Pulse drive methods; Calibration methods; Structural dynamics and Identification techniques; Passive, Semi -active and Active control; Feedback and feed forward/control strategies

**UNIT - V**
**Design, Analysis, Manufacturing and Applications of Engineering Smart Structures and Products:** Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products; Emphasis on structures, automation and precision manufacturing equipment, automotives, consumer products, sporting products, computer and telecommunications products, as well as medical and dental tools and equipment.

**TEXT BOOKS:**

1. Smart Materials and Structures/ M. V. Gandhi and_B.So Thompson/ Chapman & Hall, London; New York, 1992 (ISBN 0412370107).
2. Smart Structures and Materials/ B.Cui Shaw/Artech House, Boston, 1996 (ISBN:0890066817)
3. Smart Structures; Analysis and Design/ A.V. Srinivasan/ Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

**REFERENCES:**

1. Electro ceramics: Materials, Properties/ A.J. Moulson and J.M-Herbert/ Wiley/ 2nd Edition, (ISBN: 0471497479).
2. Piezoelectric Sensories: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers/ G. Gautschi/ Springer, Berlin; New York,2002 (ISBN:3540422595) Piezoelectric Actuators and wtrasonic Motors/ K.Uchino/ Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. TECH. II Year I Sem. (DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING)**

**INTELLIGENT MANUFACTURING SYSTEMS (Professional Elective - V)**

**UNIT - I:**
Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, CAM**,** CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture, and Data Flow, System Operation.

**UNIT - II:**
Components of Knowledge Based Systems - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

**UNIT - III:**
Machine Learning - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

**UNIT - IV:**
Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.

**UNIT - V:**
Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

**TEXT BOOKS:**
1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4. Neural networks: A comprehensive foundation/ Simon Haykin/ PHI.

**REFERENCES:**
1. Artificial neural networks/ B. Vegnanarayana/PHI
2. Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
3. Neural networks/ James A Freeman David M S kapura/ Pearson education/2004
4. Introduction to Artificial Neural Systems/Jacek M. Zurada/JAICO Publishing House Ed. 2006.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**M. Tech. DESIGN FOR MANUFACTURING/ DESIGN AND MANUFACTURING**

**ENGLISH FOR RESEARCH PAPER WRITING (Audit Course - I & II)**

**Prerequisite:** None

**Course objectives:** Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

**UNIT-I:**
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT-II:**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

**UNIT-III:**
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

**UNIT-IV:**
key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

**UNIT-V:**
skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

**UNIT-VI:**
useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

**TEXT BOOKS/ REFERENCES:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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**DISASTER MANAGEMENT (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches,
- planning and programming in different countries, particularly their home country or the countries they work in

**UNIT-I:**
**Introduction:**
Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

**UNIT-II:**
**Repercussions Of Disasters And Hazards**:
Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**UNIT-III:**
**Disaster Prone Areas In India:**
Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

**UNIT-IV:**
**Disaster Preparedness And Management:**
Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

**UNIT-V:**
**Risk Assessment Disaster Risk:**
Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co- Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

**UNIT-VI:**
**Disaster Mitigation:**
Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

**TEXT BOOKS/ REFERENCES:**

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “’New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.),” Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies” ,Deep &Deep Publication Pvt. Ltd., New Delhi.

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**SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:**

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

**Course Outcomes:** Students will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

**UNIT-I:**
Alphabets in Sanskrit,

**UNIT-II:**
Past/Present/Future Tense, Simple Sentences

**UNIT-III:**
Order, Introduction of roots,

**UNIT-IV:**
Technical information about Sanskrit Literature

**UNIT-V:**
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

**TEXT BOOKS/ REFERENCES:**

1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

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**VALUE EDUCATION (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

**Course outcomes:** Students will be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

**UNIT-I:**
Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

**UNIT-II:**
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

**UNIT-III:**
Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness.

**UNIT-IV:**
Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

**UNIT-V:**
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation, Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

**TEXT BOOKS/ REFERENCES:**

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

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**CONSTITUTION OF INDIA (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

**Course Outcomes:** Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

**UNIT-I:**
**History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)

**UNIT-II:**
**Philosophy of the Indian Constitution:** Preamble**,** Salient Features

**UNIT-III:**
**Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality**,** Right to Freedom**,** Right against Exploitation**,** Right to Freedom of Religion**,** Cultural and Educational Rights**,** Right to Constitutional Remedies, Directive Principles of State Policy**,** Fundamental Duties.

**UNIT-IV:**
**Organs of Governance:** Parliament**,** Composition**,** Qualifications and Disqualifications**,** Powers and Functions**,** Executive**,** President**,** Governor**,** Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions

**UNIT-V:**
**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

**UNIT-VI:**

**Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

**TEXT BOOKS/ REFERENCES:**

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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**PEDAGOGY STUDIES (Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:** Students will be able to:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**Course Outcomes:** Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

**UNIT-I:**
**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching.

**UNIT-II:**
**Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

**UNIT-III:**
Evidence on the effectiveness of pedagogical practices, Methodology for the indepth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

**UNIT-IV:**
**Professional development:** alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

**UNIT-V:**
**Research gaps and future directions:** Research design**,** Contexts**,** Pedagogy**,** Teacher education**,** Curriculum and assessment**,** Dissemination and research impact.

**TEXT BOOKS/ REFERENCES:**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
**7.** www.pratham.org/images/resource%20working%20paper%202.pdf.

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## STRESS MANAGEMENT BY YOGA (Audit Course - I & II)

**Prerequisite:** None

**Course Objectives:**

- To achieve overall health of body and mind
- To overcome stress

**Course Outcomes:** Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

**UNIT-I:**
Definitions of Eight parts of yog. (Ashtanga)

**UNIT-II:**
Yam and Niyam.

**UNIT-III:**
Do`s and Don't's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

**UNIT-IV:**
Asan and Pranayam

**UNIT-V:**
i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

**TEXT BOOKS/ REFERENCES:**

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**
**(Audit Course - I & II)**

**Prerequisite:** None

**Course Objectives:**

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

**Course Outcomes:** Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

**UNIT-I:**

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

**UNIT-II:**

Neetisatakam-Holistic development of personality

- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

**UNIT-III:**

Approach to day to day work and duties.

- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

**UNIT-IV:**

Statements of basic knowledge.

- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta:

**UNIT-V:**

- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

**TEXT BOOKS/ REFERENCES:**

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.