MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
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M.TECH – CAD/CAM

COURSE STRUCTURE (R24)

Applicable From 2024-25 Admitted Batch

S. No	Category	Breakup of credits (Total 68 credits)
1	Programme Core	20
2	Professional Elective	15
3	Open Elective	3
4	Mandatory Credit Course	2
5	Project Work	28
6	Audit Course	-
	Total Credits	**68**

I YEAR I SEMESTER

S. No.	Course Code	Course Title	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1	2414001	Advanced CAD	PC	3	0	0	3	40	60	100
2	2414002	Additive Manufacturing	PC	3	0	0	3	40	60	100
3		Professional Elective - I	PE	3	0	0	3	40	60	100
4		Professional Elective - II	PE	3	0	0	3	40	60	100
5	2415502	Research Methodology and IPR	MC	2	0	0	2	40	60	100
6	2414040	Advanced Computer Aided Design Lab	PC	0	0	4	2	40	60	100
7	2414041	3D Printing Lab	PC	0	0	4	2	40	60	100
8		Audit Course-I	AC	2	0	0	0	100	-	100
Total Credits				**16**	**0**	**8**	**18**	**380**	**420**	**800**

I YEAR II SEMESTER

S. No.	Course Code	Course Title	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1	2424003	Computer IntegratedManufacturing	PC	3	0	0	3	40	60	100
2	2424004	Manufacturing Systems:Simulation Modelling & Analysis	PC	3	0	0	3	40	60	100
3		Professional Elective - III	PE	3	0	0	3	40	60	100
4		Professional Elective - IV	PE	3	0	0	3	40	60	100
5	2424042	Simulation of Manufacturing Systems Lab	PC	0	0	4	2	40	60	100
6	2424043	Computer AidedManufacturing Lab	PC	0	0	4	2	40	60	100
7	2424044	Mini Project With seminar	PS	0	0	4	2	40	60	100
8		Audit Course - II	AC	2	0	0	0	100	-	100
Total Credits				**14**	**0**	**12**	**18**	**380**	**420**	**800**

II YEAR I SEMESTER

S. No.	Course Code	Course Title	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1		Professional Elective - V	PE	3	0	0	3	40	60	100
2		Open Elective	OE	3	0	0	3	40	60	100
3	2434045	Dissertation Work Review – I	PS	0	0	12	6	100	0	100
Total Credits				**6**	**0**	**12**	**12**	**180**	**120**	**300**

***Important: *Open Elective subject must be chosen from the list of open electives offered by OTHER departments.**

II YEAR II SEMESTER

SL. No.	COURSE CODE	COURSE TITLE	Course Area	Hours Per Week			Credits	Scheme of Examination Maximum Marks		
				L	T	P		Internal (CIE)	External (SEE)	Total
1.	2444046	Dissertation Work Review – II	PS	0	0	12	6	100	0	100
2.	2444047	Dissertation Viva - Voce	PS	0	0	28	14	0	100	100
TOTAL				**0**	**0**	**40**	**20**	**100**	**100**	**200**

Professional Elective - I

S.No	Course Code	Course Title
1	2414011	Finite Element and Boundary Element Methods
2	2414012	Experimental Stress Analysis
3	2414013	Green Manufacturing

Professional Elective - II

S.No	Course Code	Course Title
1	2414014	Automation in Manufacturing
2	2414015	Computer Aided Process Planning
3	2414016	Industrial Robotics

Professional Elective - III

S.No	Course Code	Course Title
1	2424017	Intelligent Manufacturing Systems
2	2424018	IOT & Industry 4.0
3	2424019	Optimization Techniques & Applications

Professional Elective - IV

S.No	Course Code	Course Title
1	2424020	Mechatronics
2	2424021	MEMS: Design and Manufacturing
3	2424022	Fuzzy Logic & Neural Networks

Professional Elective - V

S.No	Course Code	Course Title
1	2434023	Design for Manufacturing & Assembly
2	2434024	Composite Materials
3	2434025	Artificial Intelligence Manufacturing

List of Open Elective

S.No	Course Code	Course Title
1	2434030	Business Analytics
2	2434031	Waste to Energy
3	2434032	Concurrent Engineering
4	2434032	Industrial Safety

Audit Course – I

S. No.	Course Code	Audit Course Title
1	2410001	English for Research Paper Writing
2	2410002	Disaster Management
3	2410003	Sanskrit for Technical Knowledge
4	2410004	Value Education

Audit Course – II

S. No.	Course Code	Audit Course Title
5	2420005	Constitution of India in Practice
6	2420006	Pedagogy Studies
7	2420007	Stress Management by Yoga
8	2420008	Personality Development Through Life Enlightenment Skills

I–I

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ADVANCED CAD (Professional Core- I)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

Course Objectives

1. To study about the CAD process and concept of geometric modelling
2. To study the concepts of wireframe modelling
3. To study the concepts related to surface modelling
4. To study the concepts of solid modelling
5. To study about geometric transformations techniques, data exchange formats and mechanical tolerance

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

1. Understand the CAD process and geometric modelling concepts
2. Analyse the utility and application of wire frame modelling
3. Understand the concepts of surface modelling
4. Understand and apply the concepts of solid modelling techniques.
5. Understand graphics by using transformations and analyse the utility of data exchange formats with dimensioning and tolerances.

UNIT- I:

CAD Tools: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software.

Basics of Geometric Modelling: Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modelling facilities desired.

UNIT- II:

Geometric Modeling: Classification of wireframe entities, Curve representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spline curvewire, NURBS, Curve manipulations.

UNIT- III:

Surface Modeling: Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Spline surface, Blending surface, Surface manipulations.

UNIT- IV:

Solid Modelling: Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling.

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UNIT- V:

Transformations:2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection, orthotropic projection, isometric projection, Hidden surface removal, shading, rendering.

Evaluation Criteria: Evaluation criteria of CAD software, Data exchange formats: GKS, IGES, PHIGS, CGM, STEP

Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size (RFS).

TEXT BOOKS:

1. CAD/CAM Concepts and Applications/ Alavala/ PHI.
2. Mastering CAD/CAM / IbrhimZeid / McGraw Hill International.
3. CAD/CAM Principles and Applications/ P.N. Rao/TMH/3rd Edition

REFERENCES BOOKS:

1. CAD/CAM /Groover M.P./ Pearson education
2. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
3. Principles of Computer Aided Design and Manufacturing/ Farid Amirouche/ Pearson
4. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson.

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ADDITIVE MANUFACTURING (Professional Core- II)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

Prerequisites: Basics of Manufacturing, Basic knowledge in Calculus, Physics, Thermodynamics, and Chemistry

Course Objectives: The objective of the Course is

1. To understand the fundamentals for additive manufacturing and its terms.
2. To know various types of liquid based and solid based AM technologies.
3. To know various types of powder based AM technologies with LENS and rapid tooling.
4. To understand the various types of Pre-processing, processing, post-processing errors in AM. Also to know the various types of data formats and software's used in AM.
5. To know the various applications of AM in design analysis, aerospace, automotive, biomedical and other fields

Course outcomes:

1. Understand the fundamentals of prototyping and automated processes
2. Analyse the utility and application of liquid and solid based AM systems
3. Understand the concepts of powder based AM systems and Rapid tooling
4. Utilize the AM Data formats and software's
5. Utilize the AM for various practical applications

UNIT–I:

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

UNIT–II:

Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Micro fabrication.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

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UNIT–III:

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT–IV:

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, Surgi Guide, 3-matic, Simplant, Mesh Lab.

UNIT–V:

AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Web Based Rapid Prototyping Systems

TEXTBOOK:

1. Rapid prototyping: Principles and Applications by Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010.

REFERENCE BOOKS:

1. Rapid Manufacturing by D.T. Pham and S.S. Dimov, Springer, 2001.
2. Wholers Report 2000 by Terry Wohlers, Wohlers Associates, 2000.
3. Rapid Prototyping & Engineering Applications by Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.

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FINITE ELEMENT AND BOUNDARY ELEMENT METHODS
(Professional Elective - I)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

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 of 2D & 3D.
- Solve structural, thermal, fluid flow problems.
- Know the application of plate bending and nonlinear finite element of solids.
- Use professional-level finite element software to solve engineering problems in boundary element method.

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.

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UNIT–IV:

Plate Bending: Introduction – Plate behavior – C^1(Kirchoff) Plate elements – C^0(Mindlin) Plate elements – Mindlin beam – More devices for C^0Plate 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

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EXPERIMENTAL STRESS ANALYSIS (Professional Elective - I)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

Course Objectives:

- To understand two-dimensional elasticity.
- Expose the students with torsion of circular and non-circular sections.
- Impart knowledge on free and force vibrations.
- To study transient vibrations
- To know classical and energy methods for free and forced vibrations of strings bars.

Course Outcomes: Upon completion of this course the student will be able to:

- Explain two-dimensional elasticity.
- Identify the difference between torsion of circular and non-circular sections.
- Understand free and force vibrations and compute natural frequency.
- Solve problems on Transient vibrations
- understand classical and energy methods for free and forced vibrations of strings bars.

UNIT-I:

Two-dimensional elasticity theory in Cartesian coordinates, plane stress problem in polar coordinates Thick cylinders, Rotating discs - stress concentration.

UNIT- II:

Torsion of non-circular prismatic sections, rectangular and axisymmetric, Circular plates, introduction to shell theory — contact stresses.

UNIT- III:

Single degree freedom, two-degree freedom system without and with damping - Free and forced vibrations, Transient vibrations.

UNIT- IV:

Transient vibrations of single- and two-degree freedom systems, multi-degree of freedom systems - applications of matrix methods, continuous systems.

UNIT -V:

Free and forced vibrations of strings bars and be CAD/CAM. Principle of orthogonality - classical and energy methods.

TEXT BOOKS:

1. Theory of Elasticity/Timoshenko S.P. and Goodier J. N./ Koakusha Publishers
2. Advanced strength of materials / Den Hortog J.P./Torrent
3. Mechanical Vibrations/ Den Ilartog J.P./ Dover Publications
4. Theory of Vibrations with Applications/ Thomson W.T./ CBS Publishing
5. Mechanical Vibrations/ Rao S.S./ Addison Wesley Longman

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GREEN MANUFACTURING (Professional Elective - I)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

Course Objectives:

1. Provide knowledge on Sustainable Manufacturing, its Scope, Need and Benefits.
2. Expose the students with various Tools and Techniques of Sustainable Manufacturing.
3. Impart knowledge on Environmental Impact Assessment towards sustainable manufacturing.
4. Design Eco friendly products and to have knowledge on various recycling methods.
5. Implement idea towards frameworks for measuring sustainability.

Course Outcomes: Upon completion of this course the student will be able to:

1. Explain the importance of sustainable development.
2. Identify the link between manufacturing process models and sustainable manufacturing metrics for product and process improvement
3. Understand the three pillars of sustainability and how they are manifested in sustainable manufacturing.
4. Incorporate economic, environmental, and social aspects into decision making processes using multi-criteria decision-making methods.
5. Exhibit competence on the usage and applicability of sustainability tools. Compute sustainability performance through the indicators.

UNIT-I:

Concepts of sustainability and sustainable development – Need for sustainable development - Components of sustainability- Social, Economic, Environmental dimensions - Linkages between technology and sustainability - Sustainable Manufacturing –Scope, Need and Benefits.

UNIT-II:

Tools and Techniques of Sustainable Manufacturing – Environmental Conscious Quality Function Deployment, Life cycle assessment, Design for Environment, R3 and R6 cycles, Design for Disassembly -Sustainable Product Development – Various Phases.

UNIT-III:

EIA Methods –CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters - Interactions between energy and technology and their implications for environment and sustainable development.

UNIT-IV:

Design for recycling – Eco friendly product design methods – Methods to infuse sustainability in early product design phases – Multi-Criteria Decision Making in Sustainability.

UNIT-V:

Frameworks for measuring sustainability- Indicators of sustainability – Environmental, Economic, Societal and Business indicators - Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.

TEXT BOOK:

1. G. Atkinson, S. Dietz, E. Neumayer, — "Handbook of Sustainable Manufacturing". Edward Elgar Publishing Limited,2007.

REFERENCES BOOKS:

1. D. Rodick, "Industrial Development for the 21st Century: Sustainable Development Perspectives", UN New York,2007.

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AUTOMATION IN MANUFACTURING (Professional Elective - II)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

Prerequisites: Production Technology, Machine Tools, Operations Research

Course Objectives:

1. Understanding Automation.
2. To know Material handling.
3. Expose manual assembly lines.
4. Impart knowledge on transfer lines.
5. To study automated assembly systems.

Course Outcomes: Upon completion of this course the student will be able to:

1. Illustrate the basic concepts of automation in manufacturing.
2. Describe the importance of automated material handling and storage systems.
3. Explain manual assembly lines.
4. Analyze various transfer lines.
5. Interpret the importance of automated assembly systems.

UNIT- I:

Introduction to Automation: Automation in Production Systems-Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies. Manufacturing operations, Production Concepts and Mathematical Models. Costs of Manufacturing Operations, Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation.

UNIT- II:

Introduction to Material Handling: Overview of Material Handling Equipment, Considerations in Material Handling System Design, the 10 Principles of Material Handling. Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems. Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems. Automatic data capture-overview of Automatic identification methods, bar code technology, other ADC technologies.

UNIT - III:

Manual Assembly Lines - Fundamentals of Manual Assembly Lines, Alternative Assembly Systems, Design for Assembly, Analysis of Single Model Assembly Lines, Line balancing problem, largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights Method, Mixed Model Assembly Lines, Considerations in assembly line design.

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UNIT- IV:

Transfer lines, Fundamentals of Automated Production Lines, Storage Buffers, and Applications of Automated Production Lines. Analysis of Transfer Lines with no Internal Storage, Analysis of Transfer lines with Storage Buffers.

UNIT- V:

Automated Assembly Systems, Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems - Parts Delivery System at Work Stations, Multi- Station Assembly Machines, Single Station Assembly Machines, Partial Automation.

TEXT BOOKS:

1. Automation, Production systems and computer integrated manufacturing by Mikel P. Groover, Pearson Education.

REFERENCE BOOKS:

1. CAD CAM: Principles, Practice and Manufacturing Management by Chris Mc Mohan, Jimmie Browne, Pearson Edu. (LPE)
2. Automation by Buckinghsm W, Haper & Row Publishers, New York, 1961
3. Automation for Productivity by Luke H.D, John Wiley & Sons, New York, 1972.

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COMPUTER AIDED PROCESS PLANNING (Professional Elective - II)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

Course Objectives:

1. Provide knowledge on process planning.
2. Expose the students with various part design representation.
3. Impart knowledge on process engineering and process planning.
4. To design a computer aided process planning systems.
5. Implement integrated process planning systems.

Course Outcomes: Upon completion of this course the student will be able to:

1. Explain the importance of process planning.
2. Identify the link between OPTIZ and MICLASS system
3. Understand process engineering and process planning.
4. Know different computer aided process planning systems.
5. Exhibit competence on the usage integrated process planning systems.

UNIT- I:

Introduction: The Place of Process Planning in the Manufacturing Cycle-Process planning and production Planning-Process planning and Concurrent Engineering, CAPP, Group Technology.

UNIT- II:

Part Design Representation: Design Drafting-Dimensioning-Conventional Tolerance- Geometric Tolerance-CAD-input/output devices -Topology - Geometric Transformation - Perspective Transformation-Data Structure-Geometric modelling for process planning--GT Coding-The OPITZ system-The MICLASS System.

UNIT- III:

Process Engineering and Process Planning: Experience based planning-Decision table and Decision Trees-Process capability analysis-Process Planning-Variant process planning-Generative Approach-Forward and backward planning, Input format, AI.

UNIT- IV:

Computer Aided Process Planning Systems: Logical Design of process planning- Implementation Considerations-Manufacturing system components, Production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

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UNIT-V:

An Integrated Process Planning Systems: Totally integrated process planning systems-An Overview-Modulus Structure-Data Structure-Operation-Report Generation, Expert process planning

TEXT BOOKS:

1. Gideon Halevi and Roland D. Weill, "Principle of process planning- A Logical Approach", Chapman & Hall, 1995
2. Chang T. C. & Richard A. Wysk, "An Introduction to automated process planning systems", Prentice Hall 1985.

REFERENCES:

1. Chang, T.C., "An Expert Process Planning System", Prentice Hall,1985
2. Nanua Singh, "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley &Sons,1996
3. Rao P.N., "Computer Aided Manufacturing", Tata McGraw Hill Publishing Co., 2000.

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INDUSTRIAL ROBOTICS (Professional Elective - II)

M. Tech I Year I Sem

L	T	P	C
3	0	0	3

Prerequisites: Kinematics of machinery

Course Objectives:

1. To demonstrate knowledge of different types of actuators used in robotic systems.
2. To analyze the position and velocity kinematics of a robot arm, implement in 2D.
3. To analyze the dynamics of a robot arm, implement in 2D.
4. To analyze sensor signals to implement real-time control algorithms.
5. To demonstrate knowledge of error propagation in electrical, mechanical and computational systems.
6. To construct, program, and test the operation of a robotic system to perform a specified task.

Course Outcomes: After doing this course, the student will be able to,

- Understand the evolution, classification, structures and drives for robots.
- Perform motion analysis through kinematic approach of manipulators.
- Understand robot dynamics and machine vision for robotics.
- Learn and write robot programming languages.
- Expose the students to build a robot for any type of application.

UNIT-I:

Introduction: Automation and Robotics, Robot anatomy configuration, motions joint motion and notation, work volume, robot drive system, control system and dynamic performance, precision of movement.

Control System and Components: basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal & External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics, Power Transmission Systems.

UNIT-II:

Motion Analysis and Control: Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward & Inverse transformations, problems on planar & spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, manipulator path control: Slew, Joint Interpolated &Straight line motions, trajectory planning: Joint space scheme, Cartesian space scheme, Cubic Polynomial fit without and with via point, blending.

UNIT-III:

Robot Dynamics: Lagrange – Euler & Newton - Euler formulations, problems on two link planar manipulators, configuration of robot controller.

End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

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UNIT-IV:

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations.

Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions.

UNIT-V:

Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection, Work cell controller.

Robot Applications: Material transfer, Machine loading/unloading. Processing operations, Assembly and Inspection, Future Applications.

TEXT BOOKS:

1. Introduction to Robotics Mechanics & Control by John J.Craig, Pearson
2. Industrial robotics by Mikell P.Groover, McGraw Hill.

REFERENCE BOOKS:

1. Industrial robotics by Mikell P.Groover, McGraw Hill
2. Robotics by K.S.Fu, McGraw Hill.
3. Introduction to Robotics Mechanics & Control by John J.Craig, Pearson
4. Robot Analysis by Lung Wen Tsai, John Wiley & Sons
5. Robot Analysis and Control by Asada H. and J. E. Slotin, Wiley, New York

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RESEARCH METHODOLOGY AND IPR

M. Tech I Year I Sem

L	T	P	C
2	0	0	2

Prerequisite: None

Course Objectives:

1. To understand the research problem
2. To know the literature studies, plagiarism and ethics
3. To get the knowledge about technical writing
4. To analyze the nature of intellectual property rights and new developments
5. To know the patent rights

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

1. Understand research problem formulation.
2. Analyze research related information and plagiarism
3. Format of research proposal with presentation
4. Understanding the nature of intellectual property.
5. Understand patent rights.

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.

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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)

M. Tech I Year I Sem

L	T	P	C
0	0	4	2

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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3D PRINTING LAB (Lab - II)

M. Tech I Year I Sem

L	T	P	C
0	0	4	2

PRE-REQUISITES: None

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List of Experiments:

1. Review of CAD Modeling Techniques and Introduction to RP
2. Forming Groups & Assigning Creative Idea
3. Generating STL files from the CAD Models & Working on STL files
4. Modeling Creative Designs in CAD Software
5. Assembling Creative Designs in CAD Software
6. Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)
7. Simulation in Catalyst Software
8. Sending the tool path data to FDM RP machine
9. Fabricating the physical part on FDM RP machine
10. Removing the supports & post processing (cleaning the surfaces)
11. Demonstrating Creative Working Models
12. Converting CT/MRI scan data into STL file using MIMICS software (Demo)

Note: Conduct any Ten exercises from the list given above.

I–II

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COMPUTER INTEGRATED MANUFACTURING
(Professional Core – III)

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To understand the role of computers in manufacturing
2. To provide an in-depth understanding of manufacturing and database systems
3. To provide an understanding of needs of the market and design the product
4. To design and develop material handling, storage and retrieval systems for specific cases of manufacturing
5. To develop CIM systems for current manufacturing scenario by using computer and networking tools.

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

1. Select the necessary computing tools for development of product
2. Use appropriate database systems for manufacturing a product and store the same for future use
3. Use modern manufacturing techniques and tools including principles of networking
4. Apply the concepts of lean manufacturing and agile manufacturing
5. Apply the latest technology of manufacturing systems and software for the development of a product.

UNIT–I:

Basic Concepts of CIM: The meaning of Manufacturing, Types of Manufacturing; CIM Definition, Elements of CIM, CIM wheel, concept or technology, Evolution of CIM, Benefits of CIM, Needs of CIM: Hardware and software. Fundamentals of Communication: Communications Matrix. Product Development Cycle, Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Framework for integration of Lifecycle phases in CE, Concurrent Engineering Techniques, Integrated Product Development (IPD), Product Life-Cycle Management (PLM), Collaborative Product Development.

UNIT–II:

Introduction, Manufacturing Data: Types, sources; Database Terminology, Database requirements, Database models, Database Management System, DBMS Architecture, Query Language, Structural Query Language (SQL): Basic structure, Data definition Language (Create, Alter, Drop, Truncate, View), Data Manipulation Language (store, retrieve, update, delete). Illustration of Creating and Manipulating a Manufacturing Database. SQL as a Knowledge Base Query Language. Features of commercial DBMS: Oracle, MySQL, SQL Access, Sybase, DB2. Product Data Management (PDM), Advantages of PDM.

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UNIT–III:

Product Design: Needs of the market, Design and Engineering, The design Process, Design for Manufacturability (DFM): Component Design, Design for Assembly. Computer-Aided Process Planning: Basic Steps in developing a process plan, Variant and Generative Process Planning, Feature Recognition in Computer-Aided Process Planning. Material Requirements Planning (MRP), Manufacturing Resource Planning (MRP –II), Cellular Manufacturing: Design of Cellular Manufacturing Systems, Cell Formation Approaches: Machine– Component Group Analysis, Similarity Coefficients-Based Approaches. Evaluation of Cell Design. Shop-floor Control: Data Logging and Acquisition, Automated Data Collection, Programmable Logic Controllers, Sensor Technology. Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations: Linear Single Machine Layout, Circular Machine Layout, Cluster Machine Layout, Loop Layout; Operational Problems of FMS. FMS benefits.

UNIT–IV:

Introduction to Networking: Principles of Networking, Network Terminology, Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signaling methods; Network Architectures and Protocols: OSI Model, MAP & TOP, TCP/IP, Network Interconnection and Devices, Network Performance. Framework for Enterprise-wide Integration.

CIM Models: ESPRIT-CIM OSA Model, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM.

UNIT–V:

Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.

TEXT BOOKS:

1. S.Kant Vajpayee: "Principles of Computer Integrated Manufacturing", Prentice Hall India
2. Nanua Singh: "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley.

REFERENCE BOOKS:

1. P.Radhakrishnan, S.Subramanyam: "CAD/CAM/CIM", New Age International
2. Alavudeen, Venkateshwaran: "Computer Integrated Manufacturing", Prentice Hall India.

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

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

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

Course Objectives:

1. Learn way of analyzing the systems.
2. Classification of systems based nature of dynamics and knowledge of elements.
3. To develop simulation model for dynamic discrete – event stochastic system.
4. To run the model and collect the data.
5. 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 will be able to

1. Define the state of system W.R.T specified performance measures.
2. Develop simulation model for the said system
3. Generate random variates and learn various simulation languages.
4. Analyze through simulation the model and present the results to specified confidence level.
5. Apply simulation for flow shop systems and job shop systems.

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.

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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.

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INTELLIGENT MANUFACTURING SYSTEMS
(Professional Elective – III)

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To understand the computer integrated manufacturing systems
2. To provide an in-depth understanding of components of knowledge based systems
3. To provide an understanding of artificial intelligence
4. To design and develop automated process planning
5. To develop group technology for intelligent manufacturing systems.

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

1. Select the necessary tools for computer integrated manufacturing systems
2. Use appropriate knowledge of components of knowledge based systems
3. Use machine learning techniques for intelligent manufacturing systems
4. Apply the concepts of automated process planning
5. Apply the group technology for intelligent manufacturing systems.

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

REFERENCE BOOKS

1. Automation, Production Systems and CIM / Groover M.P./PHI/2007
2. Neural networks: A comprehensive foundation/ Simon Haykin/ PHI.
3. Artificial neural networks/ B. Vegnanarayana/PHI

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IOT & INDUSTRY 4.0 (Professional Elective – III)

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To understand the basics of Industry 4.0
2. To understand the Business model and impact of IIoT
3. To understand the concepts of virtual reality, lean manufacturing
4. To gain knowledge of various sensors and actuators.
5. To understand various data transmission technologies.

Course Outcomes: After completion of the course the student will be able to

1. Explain Smart Business Perspective, Cyber security, Impacts of Industry 4.0.
2. Understand the basics of the Industrial Internet of Things.
3. Understand various key technologies.
4. Implement various sensors and actuators.
5. Understand different industrial transmission technologies and IIOT applications in real life

UNIT – I:

Industry 4.0 Basics: Industrial revolution: Phases, Evolution of Industry4.0, Environmental impacts of industrial revolution, Applications, Design requirements, Drivers of Industry4.0, Sustainability Assessment of industries, Smart Business Perspective, Cyber security, Impacts of Industry 4.0.

UNIT – II:

Industrial Internet of Things- Basics: IIoT and Industry 4.0, IIC, Industrial Internet Systems, Design of industrial internet systems, Impact of industrial internet, Benefits of industrial internet, Industrial sensing, Industrial Processes, Features of IIoT for industrial processes, Industrial plant–The future architecture, Digital Enterprise

Business Models and Reference Architecture of IIoT: Definition of a business model, Business models of IIoT, Industrial Internet Reference Architecture

UNIT –III:

Key Technologies: Off-site Technologies, Cloud Computing, Fog Computing

Key Technologies: On-site Technologies, Augmented Reality, Virtual Reality, Smart factories, Lean manufacturing system, Big Data and Advanced Analytics

UNIT –IV:

Sensors: Various sensor types and their underlying working principles, Characteristics of Sensors – Resolution, calibration, accuracy and others, Sensor Categories – Thermal, Mechanical, Electrical, Optical and Acoustic sensors.

Actuators: Thermal, Hydraulic, Pneumatic, Electro mechanical Actuator

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UNIT – V:

Industrial Data Transmission and Acquisition: Architecture of various data transmission technologies like Foundation Fieldbus, Profibus, Highway Addressable Remote Transducer (HART), Interbus, Bitbus, DigitalSTROM, Controller Area Network, and other recent and upcoming Technologies. Distributed Control System, SCADA and PLC System.

IOT Applications: IoT Applications on Industrial automation, Factories and Assembly line, Plant Security and Safety, Transportation, Agriculture, Healthcare, Home Automation, Oil, Chemical and Pharmaceutical Industry and others.

TEXT BOOK:

1. Introduction to Industrial Internet of Things and Industry 4.0 by Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press
2. Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, "A Hands on Approach", University Press.
3. Dr. SRN Reddy, RachitThukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
4. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
5. Adrian McEwen, "Designing the Internet of Things", Wiley.
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.
7. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

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OPTIMIZATION TECHNIQUES AND APPLICATIONS (Professional Elective – III)

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

Pre-requisites: Operations Research

Course Objectives:

1. To know Numerical optimization techniques for single variable non- linear optimization problems.
2. To know Numerical optimization techniques for multi variable non- linear optimization problems.
3. To understand Sensitivity analysis on LPP queuing
4. To know integer programming and stochastic planning
5. 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:

1. Apply appropriate optimization techniques and solve for single variable
2. Apply appropriate optimization techniques and solve for multivariables.
3. Make sensitivity analysis to study effect of changes in parameters of LPP on the optimal solution without reworking.
4. Apply chance constrained algorithm and solve stochastic linear programme.
5. 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.

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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.LRardin
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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MECHATRONICS (Professional Elective – IV)

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives:

1. To understand the mechatronics systems
2. To provide an in-depth understanding of components of knowledge based systems
3. To provide an understanding of artificial intelligence
4. To design and develop automated process planning
5. To develop group technology for intelligent manufacturing systems.

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

1. Understand and describe different mechatronics systems
2. Explain the principle of operation of various solid state devices.
3. Describe the working of hydraulic and pneumatic actuating systems and use them appropriately.
4. Use program logic controls effectively.
5. Design mechatronic systems.

UNIT – I:

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT – II:

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

UNIT – III:

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.

UNIT – IV:

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

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UNIT – V:

System and interfacing and data acquisition, DAQS, SCADA, A to D and D to a conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/K P Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

REFERENCES BOOKS:

1. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
3. Mechatronics System Design / Devdasshetty/Richard/Thomson.
4. Mechatronics/M. D. Singh/J. G. Joshi/PHI.
5. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton
6. Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print.

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MEMS: DESIGN AND MANUFACTURING (Professional Elective – IV)

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

Prerequisites: Electronic Circuits, Basic knowledge in material science

Course Objectives:

1. Basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques.
2. To design, analysis, fabrication and testing the MEMS based components.
3. To find various opportunities in the emerging field of MEMS.

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

1. Synthesize and characterize nanomaterials for engineering applications
2. Design and analyze methods and tools for micro and nano manufacturing.
3. Improve the quality of MEMS by analyzing the variables of the underlying micro and nano manufacturing method.
4. Apply the concepts of thermo fluid engineering.
5. Select appropriate industrially-viable process, equipment and tools for a specific product.

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, Thermomechanics, Fracture Mechanics, Thin- Film Mechanics, Overview of Finite Element Stress Analysis

UNIT-IV:

Thermo Fluid Engineering & Microsystems Design: Overview of Basics of Fluid Mechanics in Macro and Micro scales, 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 Nano scale, 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.

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UNIT-V:

Materials for MEMS & Microsystems and their fabrication: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezo resistors, 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.

TEXT BOOKS:

1. Tia-Ran Hsu, MEMS & Microsystems. Design & Manufacturing, TMH 2002
2. Foundation of MEMS/ Chang Liu/Pearson, 2012

REFERENCE BOOKS:

1. An Introduction to Microelectromechanical Systems Engineering by Maluf M., Artech House, Boston 2000
2. Micro robots and Micromechanical Systems by Trimmer, W.S.N., Sensors & Actuators, Vol 19, 1989.
3. Applied Partial Differential Equations by Trim, D.W., PWS-Kent Publishing, Boston, 1990.

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FUZZY LOGIC & NEURAL NETWORKS (Professional Elective – IV)

M. TECH. I Year II Sem.

L	T	P	C
3	0	0	3

Course Objective:

1. To cater the knowledge of neural networks and fuzzy logic Control and use these for controlling real time systems.
2. To provide knowledge of adaptive fuzzy system.
3. To learn the concept of artificial neural networks.
4. To apply mapping and recurrent networks.
5. To know the cases studies of neural networks.

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

1. Expose the basic concepts of fuzzy logic control
2. Understand, describe and use adaptive fuzzy system.
3. Know the concept of artificial neural networks.
4. Interpret mapping and recurrent networks.
5. Provide adequate knowledge of application of fuzzy logic control to real time systems.

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 –Defuzzification- 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.

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SIMULATION OF MANUFACTURING SYSTEMS LAB (Lab - III)

M. TECH. I Year II Sem.

L	T	P	C
0	0	4	2

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.

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COMPUTER AIDED MANUFACTURING LAB (Lab - IV)

M. TECH. I Year II Sem.

L	T	P	C
0	0	4	2

List of Experiments:

1. CNC programs for turning- 4 exercises
2. CNC programs for milling- 4 exercises
3. Robot programming- Lead through programming using teach product, forward kinematics, inverse kinematics, trajectory planning.

II–I

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DESIGN FOR MANUFACTURING & ASSEMBLY (Professional Elective – V)

M. TECH. II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Manufacturing Processes, Engineering Materials

Course Objectives:

1. To identify the manufacturing constraints that influence the design of parts and part systems.
2. To introduce the Design for Manufacturability (DFM) methodology
3. To understand infeasible or impractical designs.
4. To know automatic assembly transfer system.
5. To understand design of manual assembly.

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

1. Understand design philosophy and able to apply general design rules for manufacturability and assembly
2. Apply principles of Design for casting and design for machining.
3. Apply the concept of DFM for, welding, forming and assembly
4. Explain automatic assembly transfer systems.
5. Apply the DFA 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.

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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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COMPOSITE MATERIALS (Professional Elective – V)

M. TECH. II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisite: Structure and properties of composite materials and design procedures for composite structures

Course objectives:

1. To identify the properties of fiber and matrix materials used in commercial composites as well as some common manufacturing teaching
2. To predict the elastic properties of both long and short fiber
3. Understand the stress-strain relations.
4. To know macro mechanical analysis of lamina and laminates.
5. Establish the failure criteria for laminated structures.

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

1. Understand and differentiate various types of composites.
2. Understand different types of reinforcements and describe various manufacturing methods of composites
3. Analyze problems on macro and micro mechanical behavior of lamina
4. Analyze problems on macro mechanical behavior of laminate
5. Use the ideas developed in the analysis of composites towards using composites in aerospace design.

UNIT - I:

Introduction to Composite Materials: Introduction, Classification Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites, Fiber-Reinforced Composites and nature-made composites, and applications.

UNIT -II:

Reinforcements: Fibers- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

UNIT -III:

Macro mechanical Analysis of a Lamina: Introduction, Definitions Stress, Strain, Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

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UNIT -IV:

Macro mechanical Analysis of Laminates: Introduction, Laminate Code, Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate, Hygro-thermal Effects in a Laminate, Warpage of Laminates.

UNIT -V:

Failure, Analysis, and Design of Laminates: Introduction, Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues.

TEXT BOOKS:

1. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By AutarK. Kaw, **Publisher:** CRC.
2. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.

REFERENCE BOOK:

1. Analysis and performance of fibre Composites by B. D. Agarwal and L. J. Broutman, Wiley-Inter science, New York, 1980.

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ARTIFICIAL INTELLIGENCE IN MANUFACTURING (Professional Elective – V)

M. TECH. II Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives: The main objective of this course is to introduce the concepts of Artificial intelligence to students and enable them to apply the concepts in various applications of manufacturing engineering.

Course Outcomes: After completion of this course the student will be able to

1. Understand concepts of AI and use various problem-solving methods
2. Understand and describe ANN architecture and apply BPNN.
3. Demonstrate image processing using ANN
4. Understand and apply various supervised and un supervised learning methods.
5. Understand and apply reinforcement learning and ensemble learning techniques

UNIT - I:

Introduction to Artificial Intelligence and Problem Solving

Definition, History, Present state of Artificial Intelligence (AI), Phases of AI, Approaches to AI - Hard or Strong AI, Soft or Weak AI, Applied AI, Cognitive AI, and Applications domains focused on manufacturing-role of AI in Industrial Revolution 4.0, components, advantages, challenges.

Problem solving methods- 1. Uninformed search includes Depth First Search (DFS), Breadth First Search (BFS), Uniform Cost Search (UCS), Depth Limited Search, Iterative Deepening Depth First Search (IDDFS) and bidirectional search. 2. Informed Search (heuristic search) includes greedy best first search, A* search, memory bounded heuristic search, learning to search better, Simple problems

UNIT - II:

Neural Networks

Introduction to Perceptron and Neural Networks, Activation and Loss functions, Single Neuron of Human and Human Brain Modelling, ANN architecture-Input layer, Hidden layer and output layer, Types of Neural Networks- Single layer feed-forward network, Multilayer feed-forward network, Multi-Layer Perceptron (MLP), Recurrent networks or feedback ANN, Characteristics of Neural Networks, Simple problems on Back Propagation Algorithms to minimize the error

UNIT - III:

Computer Vision

Introduction to Convolutional Neural Networks (CNNs), What is CNN, Common uses for CNN, CNN's Basic Architecture- LeNet, AlexNet, VGGNet, GoogleNet, ResNet, Introduction to Images, representation, image extraction, segmentation, analysis, Simple demonstration on Image processing using ANN - Face detection, Finger print recognition etc

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UNIT - IV:

Supervised and Unsupervised Learning

Unsupervised learning- Definition, basic concepts, applications, K-means Clustering, hierarchical Clustering, Dimension Reduction-PCA, Simple Examples

Supervised Learning - Definition, basic concepts, applications, Linear Regression, Multiple Variable Linear Regression, Logistic Regression, Naive Bayes Classifiers, k-NN Classification, Support Vector Machine, Simple Examples.

UNIT - V:

Reinforcement Learning and Ensemble Learning Techniques

Reinforcement Learning

Reinforcement Learning (RL) Framework, Component of RL Framework, Types of RL Systems. Q-learning, Simple Examples.

Ensemble Learning Techniques

Introduction on ensemble methods, Decision Trees, Bagging, Random Forests, Boostin, Simple Examples.

TEXT BOOKS:

1. Artificial Intelligence: A Modern Approach, Stuart Russell & Peter Norvig, Prentice-Hall, Third Edition (2009)

REFERENCES:

1. Artificial Intelligence, Ela Kumar, Wiley, 2021.
2. Artificial Intelligence: Concepts and Applications, Lavika Goel, Kindle Edition, Wiley, 2021.
3. Nature-Inspired Optimization in Advanced Manufacturing Processes and Systems, Edited by Ganesh M. Kakandikar and Dinesh G. Thakur, CRC press, First edition, 2021.

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BUSINESS ANALYTICS (Open Elective)

M. TECH. II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisite: None

Course objectives:

- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data.
- Use decision-making tools/Operations research techniques.
- Mange business process using analytical and management tools.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Outcomes: At the end of the course,

- Students will demonstrate knowledge of data analytics.
- Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
- Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
- Students will demonstrate the ability to translate data into clear, actionable insights.

UNIT- I:

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT- II:

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

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UNIT- III:

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT- IV:

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting. Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT- V:

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making. Recent Trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

TEXT BOOKS:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

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WASTE TO ENERGY (Open Elective)

M. TECH. II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: An introductory knowledge of solid and hazardous waste along with some basic understanding of solid waste management at industries

Course Objectives: To prepare the students for successful career in the energy industry, energy service companies, energy utility and consultancy agencies and in the academic and R&D institutions.
To produce graduates strong in understanding on energy resources, technologies and systems, energy management fundamentals, and capable in innovative technological intervention towards the present and potential future energy issues.
To produce energy professionals, who are sensitive to, and well aware of, the energy issues and concerns, and who can apply their specialized knowledge for the sustainable development.

Course Outcomes: Understood and acquired fundamental knowledge on the science and engineering of energy technologies and systems. Acquired the expertise and skills required for energy auditing and management, economical calculation of energy cost, development, implementation, maintenance of energy systems. Become capable of analysis and design of energy conversion systems. Acquired skills in the scientific and technological communications and project preparation, planning and implementation of energy project

UNIT-I:
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste – MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II:
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal- Methods – Yields and application- Manufacture of pyrolytic oils and gases, yields and applications. Biomass Gasification: Gasifiers- Fixed bed system- Downdraft and updraft gasifiers- Fluidized bed gasifiers- Design, construction and operation- Gasifiers burner arrangement for thermal heatingGasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-III:
Biomass Combustion: Biomass stoves- Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, Inclined grate combustors, Fluidized bed combustors, Design, construction and operation- Operation of all the above biomass combustors.

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UNIT-IV:

Biogas: Properties of biogas (Calorific value and composition)- Biogas plant technology and status- Bio energy system – Design and constructional features- Biomass resources and their classification- BIOMASS CONVERSION PROCESS

UNIT-V:

Thermo chemical conversion – Direct combustion – biomass gasification- pyroloysis and liquefaction- biochemical conversion- anerobic digestion- Types of biogas Plants- Applications Alcohol production from biomass- Bio diesel production- Urban waste to energy conversion Biomass energy programme in India.

TEXT BOOKS:

1. Non-Conversional Energy by Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology – A Practical Hand Book by Khandelwal, K.C and Mahdi, S.S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd, 1983.

REFERENCE BOOKS:

1. Food, Feed and Fuel from Biomass by Challal, D.S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology by C.Y. WereKo- Brobby and E.B. Hagan, John Wiley & Sons, 1996.

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CONCURRENT ENGINEERING (Open Elective)

M. TECH. II Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Computer-Aided Design

Course objective: To provide a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support.

Course Outcomes:

- Understand the need of concurrent engineering and strategic approaches for product design.
- Apply concurrent design principles to product design.
- Design assembly workstation using concepts of simultaneous engineering.
- Design automated fabricated systems – Case studies.

UNIT- I

Introduction: Extensive definition of CE - CE design methodologies - Organizing for CE - CE tool box collaborative product development

Use of Information Technology: IT support - Solid modeling - Product data management - Collaborative product commerce - Artificial Intelligence - Expert systems - Software hardware co-design.

UNIT- II

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.

UNIT- III

Manufacturing Concepts and Analysis: Manufacturing competitiveness - Checking the design process - conceptual design mechanism – Qualitative, physical approach - An intelligent design for manufacturing system.

UNIT- IV

JIT system - low inventory - modular - Modeling and reasoning for computer-based assembly planning - Design of Automated manufacturing.

Project Management: Life Cycle semi realization - design for economics - evaluation of design for manufacturing cost.

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UNIT- V

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.

TEXT BOOK:

1. Concurrent Engineering: Automation Tools and Technology by Andrew Kusaik, Wiley John and Sons Inc., 1992.

REFERENCE BOOKS:

1. Integrated Product Development by Anderson MM and Hein, L. Berlin, Springer Verlag, 1987.
2. Design for Concurrent Engineering by Cleetus, J. Concurrent Engineering Research Centre, Morgantown W V, 1992.

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INDUSTRIAL SAFETY (Open Elective)

M. TECH. II Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

- To provide information regarding different elements of industrial water pollution and Methods of treatment.
- To expose to the various industrial applications, maintenance, preventive measures taken against wear and tear.

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

- Know how to take safety measures in executing works
- Identify the need for maintenance (or) replacement of equipment
- Understand the need for periodic and preventive maintenance

UNIT- I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT- II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT- III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications,

i. Screw down grease cup,
ii. Pressure grease gun,
iii. Splash lubrication,
iv. Gravity lubrication,
v. Wick feed lubrication
vi. Side feed lubrication,
vii. Ring lubrication,

Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

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UNIT- IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like,

i. Any one machine tool,
ii. Pump
iii. Air compressor
iv. Internal combustion engine,
v. Boiler,
vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT- V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of:

i. Machine tools,
ii. Pumps,
iii. Air compressors,
iv. Diesel generating (DG) sets,

Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance

REFERENCE BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, McGraw Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

AUDIT COURSES

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

M. TECH. II Year I Sem.

L	T	P	C
2	0	0	0

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)

M. TECH. II Year I Sem.

L	T	P	C
2	0	0	0

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.

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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)

M. TECH. II Year I Sem.

L	T	P	C
2	0	0	0

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)

M. TECH. II Year I Sem.

L	T	P	C
2	0	0	0

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)

M. TECH. II Year I Sem.

L	T	P	C
2	0	0	0

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

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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)

L	T	P	C
2	0	0	0

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

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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)

L	T	P	C
2	0	0	0

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)

L	T	P	C
2	0	0	0

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.