CURRICULUM STRUCTURE AND DETAILED SYLLABI

FOR

MASTER OF TECHNOLOGY

IN

MANUFACTURING TECHNOLOGY PROGRAMME

(Applicable from the academic year 2021-2022)

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Haringhata-741249, Nadia, West Bengal, India

Web: https://makautwb.ac.in

Maulana Abul Kalam Azad University of Technology, West Bengal
Master of Technology in Manufacturing Technology Programme

Programme Educational Objectives (PEOs)

The objectives of the M. Tech programme in Manufacturing Technology are:

- To provide students with the technical knowledge and skills in Manufacturing Technology and related areas.
- To shape the students so that they can apply the concepts to solve the engineering problems in a scientific and systematic way.
- To mould the students in pursuing their career in the field of Manufacturing Engineering and related areas.
- To appreciate the significance of team work, collaborations and cooperation in designing, planning and implementing solutions for practical problems and facilitate networking with national research and academic organizations.

Program Outcomes (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Program Specific Outcomes (PSOs)

PSO1: Students will be able to demonstrate advanced manufacturing techniques for various applications.

PSO2: Students will be able to conduct experiments with different automated, modern and flexible manufacturing processes and systems.

PSO3: Students will be able to design and develop solutions to real time problems in the area of manufacturing technology.

Maulana Abul Kalam Azad University of Technology, West Bengal
M. Tech in Manufacturing Technology: 2021-2022
Curriculum Structure

Sl No.	Category	Subject Code	Subject Name	Total Number of contact hours			Credi
				L	T	P	
Semester-I							
Theory							
1	Program Core I	PC-MT 101	Metal Forming ,Casting & Welding	3	0	0	3
2	Program Core II	PC-MT 102	Machining Science and Machine Tools	3	0	0	3
3	Program Elective-I	PE-MT103 A/B/C	Program Elective-I	3	0	0	3
4	Program Elective-II	PE-MT104 A/B/C	Program Elective-II	3	0	0	3
5	Mandatory Learning Course	MC-MT 101	Research Methodology and IPR	2	0	0	2
6	Audit Course	AC-MT101A/B/C/D/E/F/G/H	Audit Course 1	2	0	0	0
	Total Theory			**16**	**0**	**0**	**14**
Practical							
1	Laboratory I	PC-MT191	Manufacturing Technology Lab	0	0	4	2
2	Laboratory II	PC-MT192	Machine Tools and Control Lab	0	0	4	2
	Total Practical			**0**	**0**	**8**	**4**
			Total of Semester-I	**16**	**0**	**8**	**18**
Semester-II							
Theory							
1	Program Core III	PC-MT 201	Automated Manufacturing Systems	3	0	0	3
2	Program Core IV	PC-MT 202	Advanced Manufacturing Processes	3	0	0	3
3	Program Elective-III	PE-MT203 A/B/C	Program Elective-III	3	0	0	3
4	Program Elective-IV	PE-MT204 A/B/C	Program Elective-IV	3	0	0	3
5	Audit Course	AC-MT201A/B/C/D/E/F/G/H	Audit Course 2	2	0	0	0
	Total Theory			**14**	**0**	**0**	**12**
Practical							
1	Laboratory III	PC-MT291	Modelling & Simulation Lab	0	0	4	2
2	Laboratory IV	PC-MT292	Flexible Manufacturing System Lab	0	0	4	2
	Total Practical			**0**	**0**	**8**	**4**
Sessional							
1	Mini Project	PW-MT281	Mini Project	**0**	**0**	**4**	**2**
			Total of Semester-II	**14**	**0**	**12**	**18**
Semester-III							
Theory*							
1	Program Elective-V	PE-MT 301 A/B/C	Program Elective-V	3	0	0	3
2	Open Elective	OE-MT301A/B/C/D/E/F	Open Elective	3	0	0	3
	Total Theory			**6**	**0**	**0**	**6**
Sessional							
1	Major Project	PW-MT381	Dissertation –I	0	0	20	10
			Total of Semester-III	**6**	**0**	**20**	**16**
Semester-IV							
Sessional							
1	Major Project	PW-MT481	Dissertation -II	0	0	32	16
			Total of Semester-IV	**0**	**0**	**32**	**16**
Total Credits for the programme							**68**

***Students going to Industry full time for doing their Project & Thesis work (Dissertation) may opt for completion of these courses through Massive Open Online Courses (MOOCs).*

List of Program Electives

- **Program Elective - I**
  1. Production and Operations Management (PE-MT103A)
  2. Design of Experiments (PE-MT 103B)
  3. Fabrication Technology (PE-MT103C)
- **Program Elective - II**
  1. Fluid Drives & Controls (PE-MT 104A)
  2. Robotics (PE-MT 104B)
  3. Computer Control of Machines and Processes (PE-MT104C)
- **Program Elective – III**
  1. CAD/CAM/CIM (PE-MT203A)
  2. Finite Element Methods in Engineering (PE-MT203B)
  3. Advanced Welding Technology (PE-MT203C)
- **Program Elective - IV**
  1. Advanced Material Science & Engineering (PE-MT204A)
  2. Product Design & Development (PE-MT 204B)
  3. Material Characterization Methods and Testing (PE-MT204C)
- **Program Elective - V**
  1. Quality & Reliability Engineering (PE-MT301A)
  2. Material Handling System (PE-MT301B)
  3. Quantitative Decision Making (PE-MT301C)

List of Open Electives

1. Business Analytics (OE-MT301A)
2. Industrial Safety Engineering (OE-MT 301B)
3. Operations Research (OE-MT301C)
4. Cost Management of Engineering Projects (OE-MT301D)
5. Composite Materials (OE-MT301E)
6. Waste to Energy (OE-MT301F)

Audit course 1 & 2

1. English for Research Paper Writing (AC-MT101A / AC-MT201A)
2. Pedagogy Studies (AC-MT101B/ AC-MT201B)
3. Constitution of India (AC-MT101C/ AC-MT201C)
4. Disaster Management (AC-MT101D/ AC-MT201D)
5. Value Education (AC-MT101E/ AC-MT201E)
6. Stress Management by Yoga (AC-MT101F /AC-MT201F)
7. Personality Development through Life Enlightenment Skills (AC-MT101G/ AC-MT201G)
8. Sanskrit for Technical Knowledge (AC-MT101H/ AC-MT201H)

Subject Code: PC-MT 101	**Category:** Programme Core I
Subject Name: Metal Forming, Casting & Welding	**Semester**: I
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: State different types of manufacturing processes
CO2: Explain plasticity and its application in manufacturing
CO3: State Different types of metal forming processes, casting and advanced welding processes
CO4: Solve mathematical problems on the above processes

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Basics of Manufacturing, Materials in Manufacturing, Taxonomy of manufacturing processes, Material properties and product attributes, Stress – strain relationships, Engineering materials	5
2	**Theory of Plasticity:** Theory of Plastic deformation, Yield criteria, Work of plastic deformation, Theories of Fracture, Anisotropy in sheet metal, Overview of FEM Applications in Metal Forming Analysis - Formability studies.	8
3	**Theory and Practice of Bulk Forming Processes:** Analysis of Plastic deformation in Forging, Rolling, Extrusion and rod/wire drawing processes-Effects of friction, Calculation of forces, Work done-process parameters, equipment used -Defects-Applications-Recent advances in forging, Rolling, Extrusion and drawing processes-Experimental techniques of evaluation of friction in metal forming, ring compression and double cup extrusion tests.	8
4	**Sheet Metal Forming:** Conventional processes, Forces in circular cup drawing, Redrawing, drawing of tubes from annular sheet dies, Forming limit diagram, Forming with hydrostatic pressure, Explosive forming, electrohydraulic forming, magnetic pulse forming, Principles and process parameters- Advantages - Limitations and Applications.	8
5	**Casting Metallurgy and Design** Heat transfer between metal and mould-Solidification of pure metal and Alloys-Shrinkage in cast metals -progressive and directional Solidification-Principles of grating and risering, Degasification of the melt-Design considerations in casting-Designing for directional solidification and minimum stresses-casting defects, Special Casting Processes-Shell moulding, Precision investment casting, centrifugal casting, Die casting and Continuous casting.	8

6	**Advanced Welding Processes** Physics of welding arc, heat flow in welding, theory of heat flow, cooling rate determination, selection of welding parameters based of heat flow analysis, residual stress and distortion, joint design, analysis of fracture and fatigue of welded joints. High energy density processes- Plasma keyhole welding, laser welding, Welding automation and robotics, advances in welding automation.	8
	Total number of contacts (Hr.)	45

Learning Resources:

1. M. P. Groover *Fundamentals of Modern Manufacturing* Wiley Publisher
2. Bolaji Adeyemi, Metal Forming, Khanna Book Publishing Company, Delhi
3. Schuler *Metal Forming Handbook* Springer Verlag Publication
4. Hosford, WF and Caddell, R.M. *Metal Forming: Mechanics and Metallurgy*, Prentice Hall, Eaglewood Cliffs,1993
5. Dieter, G.E. *Mechanical Metallurgy (Revised Edition II)* McGraw Hill Co,1980
6. Altan .T. *Metal Forming-Fundamentals and Applications-American Society of Metals*, Metals park,1983
7. Shiro Kobayashi, SOO-IK-oh-ALTAN, T *Metal Forming and Finite Element Method*, Oxford University Press
8. ASM Metals of Hand book on Casting - Revised Edn,1995
9. Heine loper & Rosenthal *Principals of Metal Casting* Tata McGraw Hill,1980
10. P.N. Rao *Manufacturing Technology (Foundry, Forming and Welding) II Edition* Tata McGraw Hill Pub.Co. Ltd,. New Delhi, 1998.
11. V.M. Radha Krishnan *Welding Technology & Design* New Age International Publishers
12. J.Norish *Advanced Welding Processes* Woodhead Publishing Limited

Subject Code: PC-MT 102	**Category:** Programme Core I
Subject Name: Machining Science and Machine Tools	**Semester**: I
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Explain the mechanism and mechanics of machining
CO2: Explain tool failure, determine tool life and select materials for cutting tools
CO3: Explain machinability of work materials and economics of machining
CO4: Explain the common mechanical transmissions in machine tools
CO5: Analyse the machine tool structure machine tool vibration
CO6: Explain different methods of machine tool control

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Machining Science and Geometry of cutting tools :** Definition and types of manufacturing and machining **,** machining operations-turning, hard turning boring, drilling, deep hole drilling, micro drilling, reaming, milling, planning and shaping, broaching, tapping and threading, Geometry of single point cutting tools, classification of cutting tools, geometry of multiple point cutting tools, conversion of tool geometry of single point tools.	4
2	**Mechanism of chip formation and Mechanics of Machining:** Mechanism of chip formation in machining- ductile materials, brittle materials, characteristics of continuous chip formation, classification of machining chips, shear plane, shear zone theory, orthogonal and oblique cutting: causes of chip flow deviation, angle of deviation, effective rake angle, effects of oblique cutting, chip-tool contact length**,** cutting forces in turning, drilling, milling: Force analysis by Merchant's circle diagram, force analysis under oblique cutting, estimation of milling and drilling forces, measurement of cutting forces: determination of cutting forces through measurement of elastic deflection, elastic strains, design considerations for tool-force dynamometer.	8
3	**Heat Generation:** Locations of heat generation in machining, factors affecting cutting temperature, analytical estimation of average temperature at primary shear zone, estimation of average chip-tool interface temperature, temperature in interrupted cutting, temperature in drilling, effect of thermal expansion on machining.	2
4	**Machinability of materials Machining economics:** Criteria for assessing machinability: tool life or tool wear rates, chip form and tendency to burr, achievable surface finish, achievable tolerance, functional or surface integrity, cutting temperature, mechanical properties, quantitative measure of machinability: machinability index, chip control, types of chip breaker-groove type and integral pattern-type chip breaker; chip breaking in drilling, active-chip breaking ,economic considerations, Basic factors for optimization of machining systems, optimization of machining conditions	5
5	**Cutting Tool Materials , Grinding and Superfinishing:** Tool wear - Types of tool wear according to location: flank wear, crater wear, notch wear, nose radius wear; Types of wear according mechanism of wear:	5

	thermal and mechanical cracking, edge build up, plastic deformation, edge chipping or frittering, chip hammering, tool fracture or breakage, measurement of tool wear- instruments for measurement of tool wear: Tool maker's microscope, stylus tracing instrument, volume of material worn off the flank, total volume of wear crater, specific wear rate, specific wear rate for flank wear, wear rate for crater wear, effective rake angle, grinding: Difference between machining and grinding; construction of grinding wheels, classification of grinding wheels, selection of grinding wheels, specification of grinding wheel, mechanism of material removal in grinding, mechanics of grinding, advanced grinding methods. superfinishing processes: characteristics of micro and superfinishing processes: lapping, honing, super-finishing, burnishing, polishing	
6	**Introduction to machine tools , Regulation of speed and feed rates:** Working and auxiliary motions of machine tools, parameters defining working motion of a machine tool, Power rating of electric motor in general purpose machine tool. Mechanical transmission and its elements: various mechanisms for transmission, General requirements of machine tool design, engineering design process of machine tools, Layouts of machine tools, design of speed gear box: laws of speed regulation, AP, GP, HP, LP. Selection of speed range ratio, Standard values of geometric progression, speed steps, structural diagrams and their analysis, speed chart, design of feed box, multi speed motors in machine tool drives, general recommendations for developing gear diagram determination of number of teeth of gears, determination of shaft and gear dimensions, hydraulic stepless regulation of speed and feed rates, electrical stepless regulation of speed and feed rates.	8
7.	**Design of machine tool structures and Machining Dynamics** Design criteria for machine tool structures, materials of machine tools structure, static and dynamic stiffness profiles of machine tool structures, design for machine tool structures: design for strength and stiffness, design of beds, design columns, design of housings, design of bases and tables, design of cross rails, arms, saddles and carriages, design of rams, objectives of studying machining dynamics, methods of analysing machining system, vibration of discrete systems: single degree of freedom system, multi degree freedom system	8
8.	**Control system in machine tools:** Functions of machine tool control system, speed and feed changing system with simple centralized control, pre selective control and selective control, mechanical automatic control, electrical automatic control, adaptive control system**,** fundamental concepts, classification and structure of numerical control system, NC hardware: programme reader, decoder, interpolator, drives, displacement measurement devices.	5
	Total number of contacts (Hr.)	45

Learning Resources:

1. Milton C Shaw-*Metal Cutting Principles*. Oxford University press
2. N.K. Mehta *Machine Tool Design* and *Numerical Control*, Tata McGraw-Hill Publishing
3. S.K Basu & D.K. Pal *Design of Machine Tools* Oxford & IBH Publishing Co
4. Edited by N. Acherkan *Machine Tool Design*: 4 vols, Mir Publishers, Moscow
5. A. Bhattacharya *Metal Cutting Theory and Practice*, New Central Book Agency (P) Ltd.
6. David A. Stephenson and John S. Agapiou *Metal Cutting Theory and Practice* Taylor & Francis Group
7. S.C Black, V. Chiles, A.J. Lissaman, and S.J. Martin *Principles of Engineering Manufacture,* Viva
8. H. El-Hafy *Fundamentals of Machining Process CRC Process*, Taylor and Francis Group

9. G. Boothroyd, W.A. Knight *Fundamentals of Machining and Machine Tools CRC Press* Taylor and Francis Group
10. R.K. Singal, Mridul Singal, Rishi Singal *Fundamentals of Machining and Machine Tools* I.K. International
11. G.K. Lal *Introduction to Machining Science* New Age International
12. B.L. Juneja, G.S. Sekhon and Nitin Seth *Fundamentals of Metal Cutting and Machine Tools*. New Age International Publication.

Subject Code : PE-MT103A	**Category:** Programme Elective I
Subject Name: : Production and Operations Management	**Semester**: I
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Define production & operations Management, identify it components and its applications principles
CO2: Appreciate project management and apply with project management techniques
CO3: Define inventory management, identify the role of other functional departments in inventory management
CO4: Appreciate various concepts of work design
CO5: Discuss various dimensions of quality

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to production and operations management:** Basic management functions and managerial skills, Operations strategies, Process and technologies, Concept of productivity and its analysis, Industry best practices.	6
2	**Facility capacity and layout planning** : Facility location, product and process selection, factors influencing location selection, Quantitative analysis in facility location, Plant layout, process layout, G.T based layout, Capacity and capacity planning, Decision tree analysis in facility capacity planning, facility layout planning, models of layout planning.	6
3	**Project Management:** Concept of project and project management, Networks analysis and network diagram, PERT, CPM, Float & Slack, Project crushing and smoothening.	4
4	**Inventory Management, MRP-JIT, Supply Chain Management:** Introduction, use of inventory, Inventory management system, Monte Carlo Simulation in Inventory management. Introduction, Domain applications, Cycle view of SCM, supply chain drivers, factors affecting the supply chain performances, efficient and responsive supply chain and its strategic fit, bullwhip effect of supply chain, merit and demerits of supply chain. Introduction to JIT, characteristics of JIT, Key process to eliminate waste, 5-S concept, implementation of JIT, JIT inventory and supply chain.	8
5	**Work Design:** Introduction, Job analysis and Job design, Work Measurement.	3
6	**Planning & Scheduling:** Different types of Planning: Long-tern, aggregate, short-term. Introduction, purpose of operations scheduling, factors considered for scheduling, Scheduling activities under PPC, Scheduling strategies, guidelines, methodologies.	7
7	**Quality Management:** Introduction, meaning and dimensions of Quality, TQM, ISO 9000, Quality Cost and measurement,	5

	Contributions of Quality Sages, and basic tools of quality management	
8	**Demand Forecasting:** Need and importance of forecasting, Classifications of forecasting, process, methods of forecasting, Forecasting and product life cycle, Qualitative & quantitative methods of forecasting.	6
	Total number of contacts (Hr.)	45

Learning Resources

1. Kaniksha Bedi *Production and Operations Management* Oxford Publications
2. Elwood S. Buffa & Rakesh K. Sarin *Modern Production/ Operations management*- John Wiley & Sons
3. Russell & Taylor *Operations Management* John Wiley
4. Koontz & Weihricch *Essentials of Management* TMH
5. Muhlemann, Oakland and Lockyer *Production and Operations Management* McMillian India Ltd.
6. Martin Chirstopher *Logistic and Supply Chain Management* Pearson Education
7. Chopra and Meindl *Supply Chain Management* Pearson Education

Subject Code: PE-MT103 B	**Category:** Programme Elective I
Subject Name: Design of Experiments	**Semester**: I
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: State importance of design of experiments
CO2: Explain different types of modelling
CO3: Analyze the experimental data
CO4: Represent the data in graphical form

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Basics of design of experiments and It's necessity, Laboratory experimentation and its objectives, laboratory skills, Types of experiments, Experimental design factors.	8
2	**Basics Concepts of Design of Experiments:** Introduction, Definition of terms, Calibration, Standards, Dimensions and Units, The generalized measurement system, Basic concepts in dynamic measurements, System Response, Experimental planning.	9
3	**Introduction to Modelling:** Introduction, Types of modelling, Analytical modelling, Empirical modelling, Hybrid modelling, Linear system modelling, Least square method, Non-linear system modelling, Response surface methodology.	8
4	**Experimental Data Analysis:** Introduction, causes and types experimental error, Error analysis on a common sense basis, Uncertainty Analysis, Evaluation of uncertainties for complicated data reduction, statistical analysis of experimental data, probability distribution, The Gaussian or normal error distribution, Comparison of data with normal distribution. Chi-Square Test for the Standard Deviation, Used for Chi-Square Test for the Standard Deviation, F-Test for Equality of Two Standard Deviations.	10
5	**Graphical Representation of Data:** Autocorrelation Plot, Histogram, Histogram Interpretation Block Plot, Box-Cox Linearity Plot, Box plot, Exploratory Data Analysis, DOE Contour Plot, DOE Scatter Plot, DOE Mean Plot, DOE Standard Deviation Plot, Lag Plot, Mean Plot, Scatter Plot, Scatter Plot, Weibull plot.	10
	Total number of contacts (Hr.)	45

Learning Resources:

1. J. P. Holman *Experimental Methods for Engineers* Tata McGraw Hill Edition
2. Lisa Custer, Daniel R. Mc Carville, Douglas C. *Montgomery Design and Analysis of Experiments* Paperback John Wiley & Sons Inc.; Student, Solution
3. H. V. Vu, R. B. Esfandiari *Dynamic System Modelling and Analysis* Mc Graw Hill, New York
4. H. D. Young *Statistical treatment of Experimental Data* McGraw Hill New York

Subject Code: PE-MT 103C	**Category:** Programme Elective I
Subject Name: Fabrication Technology	**Semester:** I
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Explain needs of fabrication technology and properties of materials.
CO2: Understand various metal cutting and metal forming methods.
CO3: Describe the fundamental working principle of various joining and surface treatment processes
CO4: Explain different techniques for inspection and testing
CO5: Explain the processes of composite materials fabrication processes and automation in fabrication

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Fabrication, Properties of materials, shapes and standard in metal fabrication	3
2	Metal cutting methods-Shearing, punching, nibbling, sawing, flame cutting, piercing.	10
3	Metal forming-Sheet metal forming, bending, forging, extrusion, drawing, rolling, spinning, press working	10
4	Joining processes-Bolting, riveting, welding – fusion and solid state welding, adhesive bonding, mechanical fastening, soldering, brazing.	10
5	Surface treatments, microelectronic fabrication	3
6	Inspection and quality assurance	5
7	Composite materials in fabrication-Classification of composites, thermosetting, resin used for composites, composite reinforcement, processing of composites, joining of composites.	4
8	Automation in Fabrication	4
	Total number of contacts (Hr.)	45

Learning Resources:

1. Kenyon Pitman- Basic Fabrication & Welding, Pitman Pub. Ltd.
2. F.J.M. Smith- Basic Fabrication & Welding, Longman Group Ltd.
3. Hazra & Choudhuri- Workshop Technology Vol. 1 & 2, Media Promoters & Publications
4. O.P. Khanna- Welding Technology, Dhanpat Rai & Sons
5. P.N.Rao- Manufacturing Technology, Tata McGraw Hill
6. D.E Garmo et al- Materials & Processes in Manufacturing – Wiley
7. M. P. Groover-Automation, Production systems, and Computer Integrated Manufacturing-PHI Learning Pvt. Ltd.
8. P. Radhakrishanan, S. Subramaniyam, V. Raju-CAD/CAM/CIM-New Age Publications
9. O. P. Khanna-Production technology vol-2 Dhanpat Rai Publication

Subject Code: PE-MT 104A	**Category:** Programme Elective II
Subject Name: Fluid Drives & Controls	**Semester**: I
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Know classification of fluid power, basic principle and applications in drive systems
CO2: Describe the working principles of hydraulic and pneumatic components
CO3: Identify the various configurations hydraulic and pneumatic circuits with symbols
CO4: Designate electrical Controls for Fluid Power Circuits
CO5: State principle of fluidics

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to fluid power, Classification of fluid power, Applications in drive systems, Types and Characteristics of fluids, Principle of Fluid Power.	2
2	**Pumps:** Pumping theory, pump classification-Gear, vane, piston, pump performance, pump noise, pump selection. **Actuators:** Linear Actuator (Hydraulic Cylinder)-Overall operating features, cylinder force, velocity and power, cylinder cushions, mechanics of hydraulic cylinder loadings, telescopic cylinder, design aspects. Rotary Actuator (Hydraulic Motor) -Classification: Gear, Vane, Piston; hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.	8
3	**Valves and other control components in hydraulic systems:** Direction control valves, pressure control valves, flow control valves, cartridge valves, pressure and temperature switches, hydraulic accumulators, pressure intensifiers, servo valves. **Conductors and Fittings**-Conductor sizing, pressure ratings of conductors, steel pipes, steel tubing, plastic tubing, flexible hoses, quick disconnect couplings, metric size tubing.	8
4	**Hydraulic Circuit Design and Analysis:** Control of a single acting hydraulic cylinder, control of a double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, pressure intensifier circuit, sequencing circuit, cylinder synchronization circuit, fail-safe circuit, speed control of hydraulic cylinder and hydraulic motor, hydrostatic transmission systems, analysis of hydraulic system with fictional losses, accumulator circuits, maintainability of hydraulic systems.	8
5	**Pneumatics:** Compressors, fluid conditioners, air control valves, pneumatic actuators. Pneumatic circuit design considerations, air pressure losses in pipelines, simple multi-cylinder circuits, emergency stop circuits, fail-safe circuits, two-handed control, cascade circuits, cascade circuit design procedure, group selection and stepper circuits, maintainability of pneumatic circuits.	8

6	**Electrical Controls for Fluid Power Circuits:** Electrical components, limit switches, solenoids, control of a cylinder using a single limit switch, reciprocation of a cylinder using pressure or limit switches, dual cylinder sequencing circuits, electrical control of a regenerative circuit, electro hydraulic servo system, application of Programmable Logic Controller (PLCs) in fluid power circuits.	8
7	**Introduction to Fluidics:** Principles of fluids logic control, basic fluidic devices, fluid sensors, fluidic control of fluid power systems.	3
	Total number of contacts (Hr.)	45

Learning Resources:

1. Anthony Esposito *Fluid power with applications* Prentice Hall International ,Inc.
2. S.R. Mujumdar *Oil Hydraulics* Tata Mc Graw Hill
3. S.R. Majumdar *Pneumatic System: Principles and Maintenance* Tata Mc Graw Hill
4. D.D. Banks, D.S.Banks *Industrial Hydraulics* Prentice Hall
5. A.B.Goodwin *Power Hydraulics* B.I. Publications
6. Chris Stacey- *Practical Pneumatics* Arnold Publications
7. Sadhu Singh-Fluid Mechanics & Hydraulic Machines, Khanna Publishing House.

Subject Code: PE-MT104C	**Category:** Programme Elective II
Subject Name: Computer Control of Machines and Processes	**Semester**: I
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Explain use of computer controls in machines
CO2: State principle of numerical control of machines
CO3: Explain robot technology
CO4: Know various aspects of computer process control
CO5: Explain principles sequence control and programmable controllers

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Computer in process control, Hierarchical Control, Control Networks, Interfacing, Computer Communication : Transmission, Coding, Types of communication lines, communication hardware; Network Architecture: Open System Inter Connector (OSI), LAN, Manufacturing Automation Protocol (MAP), Databases in Control, Control Hierarchy, Control Computers, Discrete event system and supervisory controller software design, software specification for a machining cell controller	10
2	**Numerical Control Machines:** Components of CNC machines; NC / CNC controls, CRT displays, drive motors, stepping motors and open-loop systems, servo motors and closed loop system, CNC machine; axes and coordinate systems; absolute and incremental programming, word address programming, part programming, programming procedure, incremental positioning, circular interpolation, tool length offset, tool diameter offset.	10
3	**Robot Technology:** Definition of Robot; robot anatomy; joints and links, common robot configurations; Robot Control Systems; Drive Systems, Types of robot control; Accuracy and Repeatability; End Effectors; Sensors in Robotics; Types of Robot Programming: manual setup, lead through programming, robot programming languages, off-line programming.	10
4	**Computer Process Control:** Definition: Computer-process interface : characteristics of manufacturing process data, process data input / output; Interface hardware : sensors and transducers, analog-to-digital converters, digital-to-analog converters, multiplexers, pulse counters and pulse generators; Computer Process Monitoring, Types of computer process control: preplanned control, direct digital control, supervisory computer control; Programming for computer process control: requirements of control programming, interrupt system, error detection and recovery, diagnostics.	10
5	**Sequence Control and Programmable Controllers:** Logic control and sequencing: logic control system, sequencing system; Logic control	5

	elements: logical AND, OR, and NOT gates, Boolean algebra, hardware for implementing combinational systems; sequencing elements; Timers, Counters; Ladder Logic Diagrams; Programmable Logic Controllers (PLC): Components of PLC, Programming the PLC, How the PLC operates, Additional capabilities of PLC.	
	Total number of contacts (Hr.)	45

Learning Resources:

1. Mikell P.Groover – *Automation, Production Systems and Computer – Integrated Manufacturing* Prentice Hall of India Pvt. Ltd.
2. N.S. Gill, Handbook of Computer Fundamentals, Khanna Publishing House
3. HMT Limited *Mechatronics,*Tata Mc Graw – Hill Publishing Company Ltd.
4. Jon Stenerson and Kelly Curran– *Computer Numerical Control : Operation and Programming,* Prentice Hall, New Jersey
5. R.S. Salaria, Computer Oriented Numerical Methods, Khanna Book Publishing Company
6. R.S. Salaria, Computer Fundamentals, Khanna Book Publishing Company
7. S.Kant.Vajpayee *Principles of computer – Integrated Manufacturing* Prentice Hall of India.
8. Thomas O. Boucher *Computer Automation in Manufacturing: An Introduction* Chapman & Hall

Subject Code: MC-MT 101	**Category:** Mandatory Learning Course
Subject Name: Research Methodology and IPR	**Semester**: I
L-T-P: 2-0-0	**Credit: 2**
Pre-Requisites: No-prerequisite	

Course Outcomes:
On successful completion of the course, the students will be able to:

CO1: Understand research problem formulation
CO2: Analyze research related information
CO3 :Follow research ethics
CO4 :Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO4: Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular
CO5: Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	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.	5
2	Effective literature studies approaches, analysis, plagiarism, Research ethics.	5
3	Effective technical writing, How to write report, Paper, Developing a Research Proposal, Format of research proposal, A presentation and assessment by a review committee.	5
4	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.	5
5	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	5
6	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.	5
	Total number of contacts (Hr.)	30

Learning Resources:

1. Stuart Melville and Wayne Goddard *Research methodology: an introduction for science & engineering students*
2. Wayne Goddard and Stuart Melvill, *Research Methodology: An Introduction*
3. Ranjit Kumar,2nd Edition *Research Methodology: A Step by Step Guide for beginners*
4. Halbert, *Resisting Intellectual Property*, Taylor & Francis Ltd,2007.
5. Mayall Industrial *Design* McGraw Hill,1992.
6. Niebel *Product Design* McGraw Hill,1974.

Subject Code: PC-MT 191	**Category:** Lab-I
Subject Name: Manufacturing Technology Lab	**Semester**: I
L-T-P-Cr: 0-0-4-2	**Credit: 2**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: After successful completion of this course, students will be able to:
CO2: Explain the need for material testing
CO3: Distinguish different types of welding
CO4: Prepare a test piece for experimentation
CO5: Identify industrial application of particular welding process and its output characteristics.
CO6: Know stamping operation

List of Experiments:

Expt. No.	Description of Topic	Contact Hrs.
1	Pre-lab talk-familiarization of experiments and machines/equipment	2
2	Material testing (tensile and hardness) of different metals)	8
3	Welding operation (virtual and manual) of test pieces by MMAW, TIG, MIG, SAW, Plasma, Spot Welding techniques and analysis of output characteristics (testing and inspection)	8
4	Turning, Milling, Drilling and shearing of work pieces	8
5	Design and drawing operation by C Type Hydraulic press	2
6	Plasma cutting operation and measurement of surface characteristics of different specimen	2
	Total number of contacts (Hr.)	30

Subject Code: PC-MT 191	**Category:** Lab-II
Subject Name: Machine Tools and Control Lab	**Semester**: I
L-T-P-Cr: 0-0-4-2	**Credit: 2**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of this course, students will be able to

CO1: Explain acceptance test of machine tools after installation
CO1: Know the techniques of determination of cutting forces of various machining operations
CO1: Analyze various hydraulic circuits applied to control of machine tools
CO1: State the process of estimation of cutting tool angles
CO1: Explain the technique of material characterization of work pieces
CO1: Know surface roughness measurement of work pieces

List of Experiments:

Expt. No.	Description of Topic	Contact Hrs.
1	Acceptance test (Lathe and Milling)	4
2	Determination cutting forces of different machining operations by Lathe Tool Dynamometer, Milling Tool Dynamometer, Drilling Tool dynamometer	8
3	Analysis of control of hydraulic circuits applied to machine tools	4
4	Determination of shear angle, cutting tool angles by Tool Maker's Microscope	4
5	Material Characterization study of specimen by Metallurgical Microscope	6
6	Surface roughness measurement of specimen by surface hardness tester	4
	Total number of contacts (Hr.)	30

Subject Code: PC-MT 201	**Category:** Programme Core III
Subject Name: Automated Manufacturing System	**Semester**: II
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: State different types of automation process
CO2: Explain computer numerical controlled technology and its application in manufacturing
CO3: Explain group technology, flexible manufacturing system and computer integrated manufacturing
CO4: Solve mathematical problems on the above systems and process

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Concepts of Automation and Mechanizations, Technical and economic requisites, Types of Automations and its advantages and limitations, Developments in manufacturing technology in automation, A hierarchical model of factory automation, Systems requirements and automatic control technology, Classification of NC systems.	4
2	**Features of numerically controlled machines:** Fundamentals of machining, Design considerations of NC machine tools, Methods of improving machine accuracy, Increasing productivity with NC machines, Machining centres, CNC controllers.	6
3	**Fundamentals of NC part programming:** Preparatory functions, Axis motion commands, Feed and speed commands, Miscellaneous command, Conventional numerical control, Direct numerical control, Computer numerical control, Computer aided part programming, APT language basics, CAD/CAM based part programming.	8
4	**Manufacturing Planning and Control Systems:** A basic framework for manufacturing and planning, Demand management, Aggregate production planning, Master production schedule, Material requirement planning, MRP lot sizing problem, Capacity planning, Shop floor control.	8
5	**Group Technology and Cellular Manufacturing Systems:** Concept of Group Technology, Design attributes and manufacturing features, GT implementations, Part family formation, Selection of classification and coding system, Benefits of group technology, Concept of cellular manufacturing, Cell formation approaches, Economics of group tooling in cellular manufacturing, Production planning and control in cellular manufacturing.	6
6	**Flexible Manufacturing Systems:** Concept of different types of flexibility, Volume variety relationship for understanding production systems, Key characteristics of various manufacturing systems,	8

	Concept of FMS, Basic features of physical components of FMS, Basic features of control components of an FMS, Operational problems in FMS, Layout considerations Sequencing of Robot moves in Robotic cell, FMS benefits.	
7	**Enterprise Integration CIM, Future Trends:** Introduction to CIM, Network communication, Networks architecture and protocol, Database managements systems, Realizing CIM	5
	Total number of contacts (Hr.)	45

Learning Resources:

1. M. P. Groover *Automation, Production Systems and Computer-Integrated Manufacturing* Prentice Hall
2. Thomas A. *Boucher Computer Automation in Manufacturing: An Introduction* Chapman and Hall
3. Yoram Koren *Computer Control of Manufacturing Systems* McGraw Hill International Book Company
4. Nanua Singh *System Approach in Computer Integrated Design and manufacturing* John Wiley and Sons, Inc.
5. Narahari and Viswanadham *Performance Modelling and Analysis of Automated Manufacturing systems* Prentice Hall
6. James G.Bralla *Handbook of product design for manufacture* McGraw Hill Book co.,1986
7. Henry Peck *Designing for manufacture* Sir Issac Pitman & Sons Ltd.,1973.
8. Matousek *Engineering Design* Blackie & Sons,1956.
9. Tergan, Andreev and Liberman Fundamentals of Industrial Automations MIR Publishers

Subject Code: PC-MT202	**Category:** Programme Core IV
Subject Name: Advanced Manufacturing Processes	**Semester:** Second
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Understand the concept related to advanced manufacturing technologies.
CO2: Describe various hybrid machining processes, micromachining processes and intelligent machining processes
CO3: Illustrate various advances casting processes
CO4: Explain various advanced forming processes
CO5: Identify various advanced joining processes
CO6: Explain various additive manufacturing processes

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction**-Introduction, History, Development, Need, Classification and Applications of Various Advanced Manufacturing Processes.	2
2	**Advanced Machining Processes-** Basics of various modern manufacturing processes viz. EDM, ECM, AJM, WJM, USM, LBM, EBM, PAM etc., Hybrid Machining, *Hybrid Mechanical Processes*-Mechanical abrasion hybrid machining-Abrasive water jet machining, *Hybrid electrochemical processes*-Electromechanical grinding (ECG), Electrochemical drilling (ECD), Electrochemical deburring (ECDe), Laser assisted electrochemical machining (ECML), *Hybrid thermal processes*- Electrodischarge grinding, Electrodischarge machining with ultrasonic assistance (EDMUS), Electrochemical discharge grinding (ECDG). *Micro-Machining* - Diamond micromachining, Ductile regime grinding, Micro-ECM, Micro-EDM etc., Micro-milling, Micro-drilling, Laser micromachining: laser optics, laser ablation.	16
3	**Advanced Casting Processes**-Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Ceramic shell casting, Evaporative Pattern Casting Processes, Hybrid Evaporative Pattern Casting Process, Vacuum Assisted Evaporative Casting Process.	3
4	**Advanced Forming Processes**-High Energy Rate Forming Processes**:** Explosive Forming process, Electro-Hydraulic Forming, Electro-magnetic Forming, Pneumatic / Mechanical Forming, Micro wave Processing of Materials, Microwave applications and new trends, Stretch forming, Contour roll forming.	3
5	**Advanced Joining Processes**-Electron beam welding (EBW), Reduced pressure electron beam welding, Plasma keyhole welding, Friction-stir welding (FSW) & selective alloying, Friction Plug welding, Ultrasonic	12

	welding (USW), Thermal and Ultrasonic stir Welding, laser beam welding (LBW), Laser-hybrid welding processes, Remote laser welding (RLW) , resistance braze spot welding (RBSW), single sided spot welding (SSW), and tandem MIG welding, Adhesive & diffusive welding and joining processes, Metal to Composite Joining, Micro welding- Micro welding in similar and dissimilar materials, Narrow-gap welding processes.	
6	**Additive Manufacturing**-Introduction, History, Development, need, classification, technology-materials-tooling. CAD & Reverse Engineering, Liquid and Solid based Additive Manufacturing Systems, Powder based Additive Manufacturing Systems, Additive Manufacturing Applications. Rapid Prototyping- Photo Masking or Solid Ground Curing technique, LOM (Laminated Object Manufacturing), FDM (Fused Deposition Modelling), Thermo Jet Process, 3D Printing, Ballistic Particle Manufacturing (BPM), Laser Polymerization, LIGA, S-LIGA, Overview of MEMS Technology, Introduction and Exposure to nanotechnology processes and systems.	9
	Total number of contacts (Hr.)	45

Learning Resources:

1. V. K. Jain – Advanced Machining Processes , Allied Publishers Pvt. Limited, India.
2. P. K. Misra - Non-conventional Machining, Narosa Publishers.
3. Pandey & Shan - Modern Machining Processes, Tata McGraw Hill.
4. E. P. DeGarmo, J. T Black, R. A. Kohser, Materials and Processes in Manufacturing, Prentice Hall of India, New Delhi.
5. A. Ghosh, and A. K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd. New Delhi.
6. G. F. Benedict-Non-traditional Machining Processes, Marcel Dekker Inc. New York.
7. J. A. McGeough, Advanced Methods of Machining, Chapman and Hall.
8. Joseph McGeough-Micromachining of Engineering Materials, Marcel Dekker.
9. Mikell P.Groover- Fundamental of Modern Manufacturing: Materials, Processes and Syste, Willey.
10. Mark Ratner, Daniel Ratner-A general introduction to the Next Big Idea Nano Technology, Pearson Education.
11. Amit Bandyopadhyay, Susmita Bose-Additive Manufacturing, CRC Press.
12. Ian Gibson, David Rosen & Brent Stucker-Additive Manufacturing Technologies, Springer.
13. C. K. Chua, K.F. Leong, & C.S. Lim, Rapid prototyping: Principles and applications, World Scientific Publishers.

Subject Code: PE-MT203A	**Category: Programme Elective III**
Subject Name: CAD/CAM/CIM	**Semester**: II
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: No-prerequisite	

Course Outcomes: On successful completion of the course, students will be able to:

CO1: State different CAD/CAM/CIM and importance in modern manufacturing
CO2: Explain computer aided design and its importance
CO3: Explain numerical control and computer aided manufacturing
CO4: Solve mathematical problems on the above systems and process

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction** Introduction to CAD/CAM, Manufacturing system integration and its requirement, Economic justification of CAD/CAM/CIM The product Cycle and CAD/CAM, Automation and CAD/CAM.	5
2	**Fundamentals of CAD** The design process, Concurrent engineering, Modelling using CAD, A CAD system architecture, Benefits of Computer Aided Design. Representations of curves, Parametric representation of geometry, Bezier curves etc., Techniques for surface modelling, Techniques for volume modelling, boundary model, Constructive solid geometry etc.	10
3	**Interactive CAD** Introduction to computer graphics, Computer graphics hardware, two dimensional computer graphics, Vector generation, Clipping, three dimensional computer graphics, Viewing transformation, Techniques for visual realism, Interaction with the system and the model.	6
4	**The design/manufacturing interface** Conventional engineering approaches, Current theme in manufacturing engineering, Group technology, The design for manufacture and assembly, Overview of process planning techniques, Concurrent engineering.	8
5	**Numerical Control and the beginning of CAM** Basic components of NC System, The NC procedure, NC Coordinate system, NC Motion control system Applications of numerical control, Economics of numerical control	8
6	**Production planning and control** Introduction too production planning and control, Requirement planning systems, Shop floor control system, Scheduling techniques, Just in time manufacturing	5
7	**Future directions of CAD/CAM** Product data management, Product modelling, Assembly and tolerance modelling etc.	3
	Total number of contacts (Hr.)	45

Learning Resources:

1.M.P. Groover & E. W. Zimmers, Jr. *CAD/CIM – Computer Aided Design and Manufacturing* Prentice Hall.

2.Chris McMohan & Jimmi Brown- *CAD CAM* Addison Wiley

3.Radhakrishnan and Subramanyan *CAD/CAM/CIM* New Age International (P) Limited, Publishers

4.Donatas Tijunela & Kirth E *Manufacturing High Tech Handbook* Mckee-2000.

5.Narahari and Viswanadham *Performance Modelling and Analysis of Automated Manufacturing systems* Prentice Hall-1998.

Subject Code PE-MT203B	**Category:** Programme Elective III
Subject Name: : Finite Element Methods in Engineering	**Semester**: II
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Understand the fundamentals of Finite Element Methods in Engineering
CO2: Derive finite element stiffness and mass matrices
CO3: Perform static analysis, linear analysis, thermal analysis and fluid flow analysis
CO4: Analyze linear, nonlinear and simple time-dependent problems in structural discipline using finite element methods
CO5: Investigate solid mechanics, fluid flow or heat transfer problems using commercial FEM codes/ packages

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Finite Element Procedures: Introduction, Physical problems, Mathematical models, Finite element solution, Finite element Analysis as part of computer aided design.	6
2	Vectors, Matrices and Tensors: Introduction to Matrices, Vector Spaces, Tensors, The eigen problem, The Rayliegh quotient, Minimax characterization of eigenvalues, Vectors and Matrix norms.	8
3	Engineering analysis with FEM: Steady state problems, propagation problems. Eigenvalue problems, differential formulation, variational formulation, weighted residual methods, finite different differential and energy methods, language multipliers, penalty method.	8
4	Formulation of FEM: Introduction, Formulation of displacement based finite element method, General deviation, imposition of boundary conditions, generalized coordinate models for specific problems, convergence criteria, Mixed formulations, Mixed Interpolations.	8
5	Applications of FEM: Finite Element Analysis of Heat transfer problems, Analysis of field problems, Fluid flow problems, Analysis of viscous incompressible fluid flows, One and Two dimensional problems, FEM application in manufacturing technology.	6
6	Computer implementation of two-dimensional problems: Numerical considerations, Computer implementation, Pre-processor element computations, Applications of the computer programs like fem2d, Computational methodology, Modelling, Mesh generation, Mesh revision and Smoothing refinement, Pre-processing Solving, Post-processing.	6
7	Advanced FEM topics: Errors in finite element analysis, Sources of errors, Three-dimensional problems, Alternative finite element models, Commercial FEM codes/ software packages.	3
	Total number of contacts (Hr.)	45

Learning Resources:

1.Bathe, K.J *Finite Element Procedures* Prentice-Hall of India Pvt. Ltd, Third Edition, 1996.
2. J.N. Reddy *An Introduction to the Finite Element Method* McGraw-Hill, Third Edition, 1993.
3. Keneth H.Huebner, Donald L.Dewhirst, Doglas E.Smith, Ted. G. Pyrson *The Finite Element Method for Engineers* Fourth Edition, John Willey and Sons, 2001.
4. Singiresu S. Rao *The Finite Element Method in Engineering* Fifth Edition, 2010.
5. P. Seshu *Textbook of Finite Element Analysis* PHI, New Delhi, 2012.

Subject Code: PE-MT203C	**Category:** Programme Elective III
Subject Name: Advanced Welding Technology	**Semester:** II
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Describe the welding symbols, positions, and welding codes, classification of welding process, fluxes, and electrodes.
CO2: Understand the welding power sources and weldability of different materials, welding metallurgy, heat effects on weld joint.
CO3: Analyze the physics behind the welding process and design welded joints.
CO4: Explain the fundamental working principle of various advances welding processes
CO5: Understand various defects in welding and methods of inspection and computational welding mechanics

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to advanced welding processes, welding symbols, Welding Positions, welding codes, welding fluxes and coatings - type and classification; electrode codes and their critical evaluation-welding machine characteristics - conventional and pulsed power sources, inverter type, power sources for resistance welding	4
2	Weldability of plain carbon steels, stainless steel, cast iron, aluminium and its alloys, welding metallurgy, relation among TTT diagram, HAZ & weld mechanical property, effects of different process parameters on the characteristics of weldment, heat treatment of welds, effect of alloying materials, determination of preheat temperature, use of Schaeffler's diagram, weldability tests	5
3	Physics of welding arc - characteristics of arc and mode of metal transfer, heat flow in welding - significance, theory of heat flow, cooling rate determination, selection of welding parameters based on heat flow analysis, residual stress and distortion - theory of residual stresses and distortion calculation, weld distortion and defects - causes and remedies	7
4	Process descriptions of and parametric influences on fusion welding; arc welding- SMAW, GMAW, GTAW, FCAW, Stud welding and mechanical fasteners, solid state welding processes- pressure welding, friction welding, diffusion welding, resistance welding processes, explosive welding	10
5	Fundamentals of PAW, LBW, EBW, USW, FSW, under-water welding, Magnetically impelled arc welding; advanced gas tungsten arc welding, pressure welding, electromagnetic pulse welding, high velocity projectile impact welding, wire bonding, microjoining and nanojoining, hybrid welding processes, welding of plastics, ceramics and composites	14
6	Welding defects- types, causes, inspection and remedial measures; Non-destructive testing of weldments -visual inspection, dye-penetration (DP)	5

	test, ultrasonics, radiography, Magnetic particle inspection, Eddy current inspection, etc.; Destructive Testing of welded joints-Chemical tests; Metallographic tests, Hardness tests; Tensile & compressive test for groove and fillet welds, bend test, fillet weld break test, creep & fatigue testing.	
	Total number of contacts (Hr.)	45

Learning Resources:

1. American Welding Society *Welding Handbook - Welding Processes* Part 2, Vol. 3, AWS, 2004.
2. ASM International Handbook Committee *Welding, Brazing and Soldering*, ASM handbook, Vol. 6, 1993.
3. L. William *The Metallurgy of Welding* 6th Edition Andrew Publishing, NY.
4. J. Norrish *Advanced welding Processes* Woodhead publishing, 2006.
5. V. M. Radhakrishnan *Welding technology and design* New age, 2002.
6. R.S. Parmar, Welding Engineering and Technology Khanna Publishers.
7. R. W. Messler *Principles of Welding (Processes, Physics, Chemistry and Metallurgy)* Wiley Publishers, 1999.
8. S. Kou *Welding Metallurgy* John Wiley, USA, 2003.
9. Y. N. Zhou *Microjoining and Nanojoining* Woodhead publishing, 2008.
10. W. Steen *Laser Material Processing* Springer-Verlag, 1991.
11. L. E. Lindgren *Computational welding mechanic*s Woodhead Publishing Limited 2007.
12. O. Grong *Metallurgical modelling of welding*, 2nd Ed, , IOM Publication, 1997.
13. J. F. Lancaster *The Physics of welding*,Pergamon, 1986.
14. J.C. Lippold and D.J. Kotecki *Welding Metallurgy and Weldability of Stainless Steels*, Wiley-India (P) Ltd., New Delhi.
15. J. L. Morris *Welding Process and Procedures* Prentice Hall, 1955.
16. S.V. Nadkarni *Modern Arc Welding Technology* Oxford & IBH Publishing Co. Pvt. Ltd.

Subject Code: PE-MT204A	**Category:** Programme Elective IV
Subject Name: Advanced Material Science & Engineering	**Semester:** II
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

After successful completion of the course, students will be able to:-

CO1: Outline physical properties and applications of metal, ceramics, polymers & composites and the structure sensitive properties of metals and alloys.
CO2: Distinguish various types of common ceramics, processing methods, properties and their applications.
CO3: Explain types of polymers, principles polymerization processes, common polymers, properties and applications and specialized polymers.
CO4: Explain the fundamental of nanomaterials, types of nanomaterials, principle methods of nanomaterials preparation, properties and applications.
CO5: Explain types, manufacturing process, properties and applications of metal matrix, ceramic matrix and polymer matrix composites/nanocomposites.
CO6: Explain biocompatible and biodegradable materials, characteristics and applications for various biomaterials.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Materials: Introduction to metal, ceramic, polymer, composites, testing of engineering materials.	6
2	Metal & Alloys: Fundamental of metals and alloys (ferrous alloy and nonferrous alloy), phase diagram of alloy systems, stainless steel, diffusion in metal, structure sensitive properties.	6
3	Ceramics: Types of ceramics, phase diagrams of common ceramic alloys, properties of common ceramics, their common applications and processing methods, advanced ceramics.	6
4	Polymers: Types of polymers, polymerizations processes (step polymerizations and addition polymerization), solid-state properties of polymers, common polymers (properties and applications), specialty polymers (conducting polymers, heat resistant polymers), recycling of polymer wastes.	6
5	Nanostructured Materials and Properties: Fundamental of nanotechnology and nanomaterials, 1 D, 2 D and 3 D nanomaterials, nanomaterials preparation, bottom up method: chemical vapor deposition, thermal evaporation, top down methods: mechanical ball milling method, chemical and dry etching technique, electron beam lithography, applications of nanomaterials.	7
6	Composites & Nanocomposites: Types of composites, polymer matrix composites, ceramic matrix composites and metal matrix composites processing, characterization and applications, fibers as reinforcement phase, mechanism of reinforcement, interfacial bonding and composite properties, fabrication of nanocomposites.	8

7	Biomaterials: Biocompatible and biodegradable materials, polymeric biomaterials, ceramic biomaterials, metallic biomaterials, composite and nanocomposites as biomaterials, biomaterials for tissue engineering.	6
	Total Contact Hours	**45**

Learning Resources:

1. F. W. Billmeyer, Textbook of Polymer Science, John Wiley & Sons, 2007.
2. S. Kulkarni, Nanotechnology; Principles and Practices, Springer, 2015.
3. R. W. Kelsall, I. W. Tlamley, M. Geoghegan (Eds), Nanoscale Science and Technology, Wiley, 2005.
4. W. F. Smith, J. Hashemi, R. Prakash, Materials Science & Engineering, Tata McGraw-Hill Education, 2008.
5. P. M. Ajayan, L. S. Schadler, P. V. Braun (Eds), Nanocomposite Science and Technology, Wiley-VCH Verlag GmbH Co. KGaA, Wei
6. O.P. Gupta, Energy Technology, Khanna Book Publishing Company 2019.

Subject Code: PE-MT 204B	**Category:** Programme Elective –IV
Subject Name: Product Design and Development	**Semester**: II
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Develop vision of a product
CO2: Analyse market opportunity, customer need and competitiveness
CO3: Develop a concept through portfolio planning, functional modelling and concept engineering
CO4: Implement a concept through embodiment engineering, physical and analytical modelling
CO5: Design for manufacturing, assembly, environment and robustness for satisfying additional engineering specifications other than performance related metrics

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Product Development Process Tools and Scoping Product Developments** Product development Process, Product Design; Types of design and redesign, engineering design; phases of modern product development process; Reverse engineering and redesign product development process. Product development teams: definition, composition, team roles, Myer-Briggs type indicator, team structure, team building, team evaluation; Product Development Planning: Steps of planning, basic planning and scheduling tools; Definition of s-curves and new product development, technology forecasting; Basic methods to understand industrial and clarify risks: technical questioning, mission statement; Advanced method: Business case analysis, design drivers;	4
2	**Understanding Customer Needs, Establishing Product Function, Product Teardown and Experimentation** Customer satisfaction: Kano diagram, customer populations, types of customer needs, customer need models; Customer needs gathering methods. Grouping the needs: affinity diagram method, customer sort method; Determining need importance: interview data method, questionnaire method; cluster analysis method; Functional Decomposition: product function, sub function, abstraction, constraints; Developing formation trees: Function Analysis System Technique (FAST), Subtract and Operate procedure; Basics of function structure, Function structure modelling process: five phase Function structure decomposition; Product Teardown Phases, Teardown methods: Subtract and operate procedure force flow diagram; measurement and experimentation; Post teardown reporting; application of product teardown.	12

3	**Benchmarking and Establishing Engineering Specifications Product portfolios, Portfolio architecture and Product Architecture** Benchmarking: steps of product benchmarking, support tools for benchmarking; Setting product specifications: Specification process, fundamental requirements and constraints, specifications sheets, House of Quality, value analysis. Product portfolio architecture, Platform architecture: Modular family platform, steps of platform design method, Design optimization to develop non-platform based products and platform based products; Product architecture types; Product modularity: types of modularity, Methods of modularity design: clustering methods, advanced functional method.	9
4	**Generating Concepts, Concept Selection and Concept Embodiment and Modelling of Product Metrics** Concept Generating Process: basic methods, advanced methods, morphological analysis, combining solution principles; Estimating Technical Feasibility, Concept Selection Process, Pugh Concept Selection Chart, Measurement theory, Numerical Concept Scoring; Concept embodiment: refining geometry and layout, systems modelling. Model selection by performance specifications, Mathematical modelling, physical prototyping, constructing product models.	8
5	**Design for Manufacture, Assembly and Environment** Design guidelines, Manufacturing cost Analysis; Environment objectives, Basic design for environmental methods, life cycle assessment, techniques to reduce environmental impacts.	4
6	**Analytical and Numerical Model Solutions, Physical Prototypes Physical Models and Experimentation** Solution definition, Pareto optimality, Spreadsheet search, concept of optimization, analytical formulations, practical optimization. Fundamentals of prototypes, Types and uses of prototypes. Rapid prototyping techniques, scale, dimensional analysis, similitude, physical prototype design and planning; Design of experiments: definition, reduced tests, fractional experiments, statistical analysis of experiments.	5
7.	**Design for Robustness:** Quality design theory: general robust design model, robust design model construction: Taguchi's method: noise variable matrix, design variable matrix, experimental matrix, signal to noise ratio, parameter design and Taguchi's philosophy	3
	Total number of contacts (Hr.)	45

Learning Resources:

1. Kevin N. Otto and Kristin L. Wood *Product Design* Research Education, Delhi
2. Harry Cather, Richard Morris, Mathew Philip, Chris Rose (2001) *Design Engineering* Butterworth Heinemann
3. Nigel Cross *Engineering Design Methods: Strategies for Product Design* John Wiley & Sons Ltd., England
4. M.A. Annachino New *Product Development* Butterworth-Heinemann
5. George E. Dieter and Linda C. Schmidt *Engineering Design* McGraw Hill International Edition
6. Kart T. Ulrich and Steven D. Eppinger *Product Design and Development* Mc Graw Hill International Edn.

Subject Code: PE-MT204C	**Category:** Programme Elective IV
Subject Name: Material Characterization Methods & Testing	**Semester:** II
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, the students will be able to

i) Understand the fundamentals of material characterization methods & testing.
ii) Explain the concept related to various types of lights, various optical microscopes, and sample preparation.
iii) Classify different x-ray imaging techniques and its applications.
iv) Illustrate various electron microscopy technics and its application in elemental analysis and image analysis.
v) Describe different Neutron Scattering Techniques for materials characterization.
vi) Identify the applications of thermal analysis techniques and various characterization techniques to determine mechanical property.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Fundamentals of optics, Optical microscope and its instrumental details, Variants in the optical microscopes and image formation	3
2	Phase contrast, Polarised light, Differential interference contrast, Fluorescence microscopy, Sample preparation and applications	3
3	X-Ray Techniques: Elements of Crystallography, Principles of X-ray diffraction, X-ray equipment and data analysis; associated techniques in X-ray spectroscopy; Fundamentals of elemental analysis	5
4	Electron Microscopy Techniques, Specimen preparation techniques for electron microscopy in metallurgy, Elements of phase identification, grain size determination, inclusion analysis, Image analysis, etc., Electron diffraction, SEM, Failure analysis and fractography, EDAX / EPMA, TEM.	14
5	Neutron Scattering Techniques, Diffraction, inelastic scattering and reflectometry.	6
6	Thermal Analysis: Principles and applications of thermal analysis; DTA, DSC, TGA, TMA, DMA, etc.	9
7	Mechanical Property characterisation: Principles and characterisation techniques related to Tensile, compressive, hardness, fatigue, and fracture toughness properties. Deformation; Superplasticity.	5
	Total number of contacts (Hr.)	45

Learning Resources:

1. ASTM handbook, vol. 3, 1997.
2. Materials characterization, Vol. 10, ASM hand book, 1997.
3. B. D. Cullitey and S.R.Stock, *Elements of X-ray diffraction* Third edition, Prentice Hall, NJ, 2001.

4. Douglas B. Murphy *Fundamentals of light microscopy and electronic imaging* 2001, Wiley-Liss, Inc. USA.
5. Encyclopedia of Materials Characterization, Surfaces, Interfaces, Thin Films,' Editors C. Richard Brundle, Charles A.Evans, Jr.,Shaun Wilson,Butterworth-Heinemann, Boston London Oxford Singapore Sydney Toronto Wellington.
6. R.F. Speyer *Thermal Analysis of Materials* Marcel Decker, 1994.
7. S. Michael *Fundamentals of Light Microscopy* Cambridge University Press, 1982.
8. David B. Williams, C. Barry Carter *Transmission Electron Microscopy: A Textbook for Materials Science* Springer, pub. 2009.
9. Joseph I Goldstein, Dale E Newbury,Patrick Echlin and David C Joy *Scanning Electron Microscopy and X-Ray Microanalysis* 3rd Edition, 2005.
10. G.W.H. Hohne, W.F. Hemminger, H.-J. Flammersheim *Differential Scanning Calorimetry* Springer, 2nd rev. a. enlarged ed., 2003.
11. G. Dieter *Mechanical Metallurgy* Mc-Graw Hill, 1996.
12. R. E. Smallman and A.H.W. Ngan, *Physical metallurgy and advanced materials* Seventh edition, 2007, Elsevier Ltd., USA.

Subject Code: PC-MT291	**Category:** Lab-III
Subject Name: Modelling & Simulation Lab	**Semester**: II
L-T-P-Cr: 0-0-4-2	**Credit: 2**
Pre-Requisites: No-prerequisite	

Course Outcomes:
On successful completion of the course, students will be able to:

CO1: Perform 2D and 3D geometrical modelling and meshing
CO2: Demonstrate the simulation of mechanical components and systems
CO3: Conduct static, structural and thermal analyses of any manufacturing system

List of Experiments:

Expt.No.	Description of Topic	Contact Hrs.
1	Pre-Lab talk and 2-D geometrical modelling practice	6
2	3-D geometrical modelling practice	4
3	Practice on mesh preparation and applying boundary conditions	4
4	Static, structural and thermal analysis of mechanical components	4
5	Simulation of machining processes	8
6	Simulation of other manufacturing processes and systems	4
	Total number of contacts (Hr.)	**30**

Subject Code: PC-MT292	**Category:** Lab-IV
Subject Name: Flexible Manufacturing System Lab	**Semester**: II
L-T-P-Cr: 0-0-4-2	**Credit: 2**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1. Illustrate different types of pneumatic circuits
CO2. Program on different types of CNC machines
CO3. Measure torque, temperature, strain using sensors
CO4. Measure the performance of motors
CO5. Simulate CNC programs
CO6. Measure MRR and surface finish of machined components by NTM processes

List of Experiments:

Expt.No.	Description of Topic	Contact Hrs.
1	Pre Lab talk and development of different Pneumatic Circuits with a Pneumatic Trainer	4
2	a) Measurement of Load Using Load Measuring Trainer b) Measurement of Force Using Strain Measurement Trainer c) Measurement of Linear Distance Using LVDT d)Measurement of Temperature Using Temperature Sensors e)Measurement of Torque Using Torque Measuring Trainer	8
3	Speed Control of AC Drive	4
4	CNC Trainer Simulation for Turning and Threading	**4**
5	CNC Trainer Simulation for Milling	**4**
6	Measurement of MRR and surface finish with CNC Wire-Cut EDM & Micro ECM processes	**8**
	Total number of contacts (Hr.)	**30**

Subject Code: PW-MT281	**Category:** Sessional
Subject Name: Mini Project	**Semester**: II
L-T-P-Cr: -0-0-4 -2	**Credit: 2**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, the students will be able to:

CO1: Students will get an opportunity to work in actual industrial environment if they opt for internship.
CO2: In case of mini project, they will solve a live problem using software/analytical/computational tools.
CO3: Students will learn to write technical reports.
CO4: Students will develop skills to present and defend their work in front of technically

Course Contents:

Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

Subject Code: PE-MT301A	**Category:** Program Elective - V
Subject Name: Quality & Reliability Engineering	**Semester**: III
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of this course, students will be able to

CO1: Define and identify dimensions of quality of products and service
CO2: Identify different elements of COQ
CO3: Develop control charts for variable and attributes
CO4: Define reliability and its parameters
CO5: Know the technique of reliability modelling for system prediction
CO6: State different risk assessment techniques
CO7: Describe the effect of reliability in engineering design

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction of Quality Management:** Quality: Definitions of quality, dimensions of quality of a product, dimensions of quality for service variables, attribute. Statistical process controls, sampling plan; quality assurance, quality circles. Main themes of TQM: customer, process, people; Features of TQM model; Vision and Quality policy; Performance standards; Six sigma quality, Quality function deployment (QFD); Benchmarking; ISO 9000, International & National Quality awards; leading sages and their philosophy, Measure of Quality - Cost of Quality (COQ): Definitions and use of cost of Quality, elements of cost of quality.	8
2	**Continuous Improvement: applications of Basic Tools:** Kaizen, continuous improvement, continual improvement, tally sheet, frequency distributions, histogram, stem-and-leaf display, bar chart, Pareto chart, Pareto diagram, line graph or run chart, flow chart, cause-and-effect diagram, check sheet, box-plots, scatter diagrams or scatter plots, PDCA cycle,. Some Advanced Tools : Different approaches for problem solving adopted by management, brainstorming: traditional, electronic; Affinity diagram; Process capability: Relative Precision Index, Process Potential Index; Six Sigma Quality, Taguchi methods: Total loss function, design of experiments.	8
3	**Defining Reliability and Reliability Parameters** Reliability, demand time, one shot items, repeated cycles, time dependent items of specified mission continuously operating items, items in standby. Basic statistics – The Binomial distribution, the Poisson distribution, the Exponential distribution,	8

	the log normal distribution, the Weibull distribution. Reliability as a function of time, failure rate as a function of time, constant failure rate, mission reliability, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failures (MTBF), mean down time (MDT), availability, complex system, increasing failure rate, Bath tub curve. Failure density function versus operating time.	
4	**Reliability Predictions** Condition for the prediction, cycle dependent performance, confidence estimates for success probability, confidence estimates for MTBF & constant failure rate, MTBF estimates, failure rate estimates, effects of environment and stress-accelerated testing, Goodness-of-Fit Tests, Reliability Modeling for System Predictions :Systems series and parallel systems, duty cycling, redundancy: K-out-of N redundancy, standby redundancy. The Markov Model Approach to solve complex system reliability and MTBF.	8
5	**Risk Assessment** Failure Modes and Effects Analysis (FMEA), Failure Modes Effects and Critically Analysis (FMECA), RPN numbers Fault Free Analysis (FTA).	6
6	**Reliability in Engineering Design** Design synthesis, strength load interaction, reliability of the system, design based on reliability terotechnology and trends in design.	7
	Total number of contacts (Hr.)	45

Learning Resources:

1. M.P. Poonia & S.C. Sharma, Total Quality Management, Khanna Book Publishing Company
2. Paul Kales *Reliability for Technology, Engineering and Management* Prentice Hall
3. Bikas Bhadury & S.K.Basu *Terotechnology : Reliability Engineering and Maintenance Management* Asian Books Private Limited
4. E. Balguruswamy *Reliability Engineering* Tata McGraw Hill Publishing Co-Limited.
5. Amitava Mitra *Fundamentals of Quality Control and Improvement* Prentice Hall of India Pvt. Ltd., New Delhi
6. Jill A.Swift, Joel E. Ross and Vincent K.Omachonu *Principles of Total Quality* St. Lucie Press Boca
7. William J. Kolarik *Creating Quality : Concept, Systems, Strategies and Tools* McGraw-Hill Inc.
8. Donna C.S.Summers *Quality* Prentice Hall, International Inc, New Jersey
9. Douglas C.Montgomery *Introduction to Statistical Quality Control* John Wiley & Sons Incs, New York
10. Bertrand L.Hansen and Prabhakar M.Ghare *Quality Control and Application* Prentice Hall of India Pvt. Ltd., New Delhi
11. Samuel K.Ho *TQM: An Integrated Approach* Kogen page India Pvt. Ltd., New Delhi
12. D.J.Smith *Reliability Engineering* Pitman
13. L.S.Srinath *Reliability Engineering* East West Press

Subject Code: PE-MT301B	**Category:** Programme Elective V
Subject Name: Material Handling System	**Semester**: III
L-T-P: 3-0-0	**Credit:**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Know principles of material handling systems
CO2: Explain unit load concept
CO3: Know principles of working of industrial vehicles
CO4: Explain different types of conveyer systems
CO5: Know principles of working of different hoisting equipment

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Materials Handling and Principles of Material Handling:** Definition, scope and importance of Materials Handling; System concept; Classification and characteristics of materials. Significance of Materials handling principles; Different principles and suggestions for their application.	8
2	**Unit Load Concept:** Advantages and disadvantages; Load unitization processes; Pallets, skids & containers; Packaging for Materials Handling, **Classification** of Materials Handling Equipment.	6
3	**Industrial Vehicles / Trucks:** Hand trucks; Power trucks; Forklift trucks and attachments.	8
4	**Conveyors:** Belt Conveyors- characteristics, types, components, basic design considerations; Chain Conveyors-characteristics, types, components, aspects of design; Roller Conveyors-characteristics, types, components, aspect of design; Screw conveyors-characteristics, types, components, aspects of design. **,** Pneumatic & Hydraulic Conveyors	10
5	**Hoisting Equipment:** Hoists; Winches; Elevators – types and parts of hoisting equipment, design considerations, Cranes: wharf cranes, level buffing system, Derricks.	8
6.	**Auxiliary Equipment:** Gates; Feeders; chutes; Positioners; Weighing and control equipment.	5
	Total number of contacts (Hr.)	45

Learning Resources:

1.	Apple, J.M -- *Material Handling System Design,* John Wiley & Sons
2.	Allegri,T.H. *Materials Handling: Principles and Practice,* CBS Publishers & Distributors, N.Delhi
3.	Immer- *Materials Handling* , J.R, McGraw Hills

4.	Spivakovsky,A and Dyachkov,V- *Conveyors and Related Equipment*, Peace Publishers, Moscow
5.	Rudenko N.- *Materials Handling Equipment,* Peace Publishers, Moscow
6.	Alexandrov,M.P- *Materials Handling Equipment, Part-I and II,* Mir Publishers, Moscow
7.	Ray, T.K.- *Mechanical Handling of Materials,* Asian Books Private Ltd., 2004
8.	Ray, S.- *Introduction to Materials Handling,* New Age International Publishers, 2008.

Subject Code: PE-MT301C	**Category:** Programme Elective V
Subject Name: Quantitative Decision Making	**Semester**: III
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Understand solving problems and decision making using quantitative analysis.
CO2: Understand the process of modelling
CO3: Understand decision making under certainty (Optimization, Sensitivity Analysis).
CO4: Understand linear models and linear programming
CO5: Understand probability distribution and decision analysis.
CO6: Understand decision strategy

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Phases of Decision Making. Problem discovery. Problem definition. Goal setting. Developing alternatives. Evaluating Alternative and Making Choices. Nature of decision Making: Certainty, Risk and Uncertainty. Rationality. Individual Vs Group Decision Making. Introduction to modelling - steps of modelling process, , Optimization, sensitivity analysis	7
2	Correlation and Regression Analysis: Karl Pearson's Co-efficient of Correlation and Spearman's Co-efficient of Correlation by Ranking Method. Concept of Regression and the Difference between Correlation and Regression. Lines and Equations of Regression. Regression as a Predicting Tool.	10
3	Introduction to linear models and linear programming, product mix model, advertising model, production process model, work schedule model. Multi-period production model, transportation model, assignment model	10
4	Probability distribution and decision analysis, payoff table and decision tree. Discrete Distributions –Binomial Distribution, Poisson Distribution, Continuous Distributions - Normal Distribution	8
5	Planning a decision strategy. Analysis of time series: Components of a Time Series. Seasonal Variations. Least Squares Method as a Tool for Forecasting. Test of significance and Its designing: Null Hypothesis and Level of Significance. Concept of Standard Error of Mean. Confidence Limits.	10
	Total number of contacts (Hr.)	45

Learning Resources:

1. Mik Wisniewski Quantitative Analysis for Decision Makers, 7th Edition, Pearson
2. Amit Gupta, The Practice of Business Statistics, Khanna Book Publishing Company
3. M P Gupta,R P Khanna Quantitative Techniques for Decision Making Prentice Hall India Learning Private Limited
4. F.S.Hillier, G.J.Lieberman– Introduction to Operations Research; The McGraw Hill,Companies
5. Statistics for Management, Levin and Rubin, 7th Edition, Pearson
6. Statistics for Business and Economics, Anderson, Sweeney and Williams, 11th Edition, Cengage Learning
7. Acoff and Susoni, M. Operations Research

Subject Code: PW-MT381	**Category:** Major Project
Subject Name: Dissertation –I	**Semester**: III
L-T-P-Cr: - 0-0-20-10	**Credit: 10**
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course

CO1: Students will be exposed to self-learning various topics.
CO2: Students will learn to survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.
CO3: Students will learn to write technical reports.
CO4: Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience.

Guidelines:

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his/her guide and the topic of dissertation must be mutually decided by the guide and student

Subject Code: PW-MT281	**Category:** Major Project
Subject Name: Dissertation –II	**Semester**: IV
L-T-P-Cr: - 0-0-32-16	**Credit:** 16
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course

CO1: Students will be able to present and convince their topic of study to the engineering community
CO2: Students will be able to use different software/ computational/analytical tools
CO3: Students will be able to design and develop an experimental set up/ equipment/test rig
CO4: Students will be able to conduct experiments/tests on existing set ups/equipment and draw logical conclusions from the results after analyzing them
CO5: Students will be able to either work in a research environment or in an industrial environment
CO6: Students will be conversant with technical report writing

Guidelines:

It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. . The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his/her guide.

Subject Code: OE-MT301A	**Category:** Open Elective
Subject Name: Business Analytics	**Semester**: III
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Demonstrate knowledge of data analytics
CO2: Demonstrate the ability of think critically in making decisions based on data and deep analytics
CO3: Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making
CO4: Demonstrate the ability to translate data into clear, actionable insights

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	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.	8
2	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.	8
3	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.	10
4	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.	10

5	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	5
6	Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	4
	Total number of contacts (Hr.)	45

Learning Resources:

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey *Business analytics Principles, Concepts, and Applications* Pearson FT Press.
2. Vivek Bhambri, Business Anlaytics, Khanna Book Publishing Company
3. James Evans *Business Analytics* Persons Education.

Subject Code: OE-MT301B	**Category:** Open Elective
Subject Name: Industrial Safety Engineering	**Semester**: III
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to:

CO1: Explain various aspects of industrial safety and their implications.
CO2: Know fundamentals of maintenance engineering.
CO3: Identify fault tracing concept and prevention.
CO4: Explain preventive and periodic maintenance aspects.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	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.	10
2	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.	8
3	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.	9
4	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, vii Types of faults in machine tools and their general causes.	8
5	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling	10

	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.	
	Total number of contacts (Hr.)	45

Learning Resources:

1. M.P. Poonia & S.C. Sharma, Industrial Safety and Management, Khanna Book Publishing Company
2. Higgins & Morrow *Maintenance Engineering Handbook* Da Information Services.
3. H. P. Garg *Maintenance Engineering* S. Chand and Company.
4. Audels *Pump-hydraulic Compressors* McGraw Hill Publication.
5. Winterkorn, Hans *Foundation Engineering Handbook* Chapman & Hall London.

Subject Code: OE-MT301C	**Category:** Open Elective
Subject Name: Operations Research	**Semester**: III
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes

After completion of the course, students will be able to

CO1: Apply the dynamic programming to solve problems of discreet and continuous variables.
CO2: Apply the concept of non-linear programming
CO3: Able to carry out sensitivity analysis
CO 4: Able to model the real world problem and simulate it.

Module No.	Description of Topic	Contact Hrs.
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.	8
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.	8
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	10
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	9
5	Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	10
	Total number of contacts (Hr.)	45

Learning Resources

1. H.A. Taha *Operations Research, An Introduction* PHI, 2008
2. H.M. Wagner Principles *of Operations Research* PHI, Delhi, 1982.
3. J.C. Pant *Introduction to Optimization: Operations Research* Jain Brothers, Delhi, 2008
4. Hitler Libermann *Operations Research* McGraw Hill
5. Pannerselvam, *Operations Research* Prentice Hall of India 2010
6. Harvey M Wagner *Principles of Operations Research* Prentice Hall of India 2010

Subject Code: OE-MT301D	**Category:** Open Elective
Subject Name: Cost Management of Engineering Projects	**Semester**: III
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Know various cost concepts in decision making
CO2: Explain various aspects of project implementation
CO3: Explain cost behavior and profit planning marginal costing
CO4: Explain different quantitative techniques for cost management

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	10
2	Project meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.	9
3	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.	8
4	Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	9
5	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	9
	Total number of contacts (Hr.)	45

Learning Resources:

1. *Cost Accounting: A Managerial Emphasis* Prentice Hall of India, New Delhi.
2. Charles T. Horngren and George Foster *Advanced Management Accounting*
3. Robert S Kaplan Anthony A. Atkinson *Management & Cost Accounting*
4. Ashish K. Bhattacharya *Principles & Practices of Cost Accounting* A. H. Wheeler publisher
5. N.D. Vohra Quantitative *Techniques in Management* Tata McGraw Hill Book Co. Ltd.
6. Premvir Kapoor, Principles of Management, Khanna Book Publishing Company

Subject Code: OE-MT301E	**Category:** Open Elective
Subject Name: Composite Materials	**Semester**: III
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Explain functional requirements of reinforcement and matrix materials.
CO2: Distinguish various types of reinforcements.
CO3: Explain manufacturing, properties and applications of metal matrix, ceramic matrix and polymer matrix composite materials.
CO4: Explain various aspects for the strength of composite materials and their use.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to composite materials: Definition – classification and characteristics of Composite materials. Advantages and application of composites, Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.	7
2	Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibres, Kevlar fibres and Boron fibres. Properties and applications of whiskers, particle reinforcements. Mechanical Behaviour of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.	7
3	Metal Matrix Composites: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications.	7
4	Ceramic Matrix Composites: Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.	8
5	Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.	8
6	Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hydrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.	7
	Total number of contacts (Hr.)	45

Learning Resources:

1. *Materials Science and Technology: A Comprehensive Treatment, Vol. 13, Structure and Properties of Composites*, Eds by R. W. Cahn, P. Haasen, E. J. Kramer, T.-W. Chou, VCH, West Germany, 1993.
2. R. Balasubramaniam *Callister's Materials Science and Engineering* 2nd Ed, by John Wiley & Sons, NY, Indian edition, 2014.
3. G. Lubin, *Hand Book of Composite Materials* Springer, 1982.
4. K. K. Chawla *Composite Materials: Science and Engineering* 3rd Ed, Springer, 2012.
5. D. D. L. Chung *Composite Materials: Science and Applications*, Springer, 2010.
6. D. Gay, S. V. Hoa, S. W. Tsai *Composite Materials Design and Applications* CRC Press, 2000

Subject Code: OE-MT301F	**Category:** Open Elective
Subject Name: Waste to Energy	**Semester**: III
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Classify waste as fuel and get to know about various conversion devices.
CO2: Explain biogas pyrolysis and biomass gasification.
CO3: Explain biomass conversion processes.
CO4: Identify prospective use of biofuels.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digesters.	8
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	8
3	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	10
4	Biomass Combustion: Biomass stoves – Improved challahs, 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.	9
5	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 processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	10
	Total number of contacts (Hr.)	45

Learning Resources:

1. Desai, Ashok V *Non-Conventional Energy* Wiley Eastern Ltd., 1990.
2. O.P. Gupta, Energy Technology, Khanna Book Publishing Company (AICTE Recommended)
3. Khandelwal, K. C. and Mahdi, S. S. *Biogas Technology - A Practical Hand Book - Vol. I & II,* Tata McGraw Hill Publishing Co. Ltd., 1983.
4. Challal, D. S. *Food, Feed and Fuel from Biomass* IBH Publishing Co. Pvt. Ltd., 1991.
5. C. Y. WereKo-Brobby and E. B. Hagan *Biomass Conversion and Technology*, John Wiley & Sons, 1996.

Subject Code: AC-MT101B / AC-IMT201B	**Category:** Audit Course
Subject Name: English for Research Paper Writing	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Understand that how to improve your writing skills and level of readability.
CO2: Learn about what to write in each section.
CO3: Understand the skills needed when writing a Title.
CO4: Ensure the good quality of paper at very first-time submission.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper like Abstracts, Introduction.	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	Key skills needed when writing a Title, key skills needed when writing an Abstract, key skills needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	Skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills needed when writing the Conclusions.	4
6	Useful phrases, how to ensure paper is as good as it could possibly be for the first- time submission	4
	Total number of contacts (Hr.)	24

Learning Resources:

1. Busin 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.

Subject Code: AC-MT101C / AC-MT201C	**Category:** Audit Course
Subject Name: Pedagogy Studies	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Understand what pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
CO2: Identify critical evidence gaps to guide the development.
CO3: Contemplate on real-time interaction to improve curriculum and learning material.
CO4: Understand what is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	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.	6
2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.	4
3	Evidence on the effectiveness of pedagogical practices: Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school 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.	6
4	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	4
5	Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.	4
	Total number of contacts (Hr.)	24

Learning Resources:

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.

Subject Code: AC-MT101D / AC-MT201D	**Category:** Audit Course
Subject Name: Constitution Of India	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO3: Voice for the socio-economic needs of the people effectively.
CO4: Understand the complexity of Indian culture and how it is addressed within the ambit of law.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	History of Making of the Indian Constitution: Drafting Committee (Composition & Working)	4
2	Philosophy of the Indian Constitution: Preamble and Salient Features	4
3	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.	4
4	Organs of Governance: Parliament - Composition, Qualifications and Disqualifications, Powers and Functions. Executive - President, Governor, Council of Ministers. Judiciary - Appointment and Transfer of Judges, Qualifications, Powers and Functions	4
5	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.	4
6	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.	4
	Total number of contacts (Hr.)	24

Learning Resources:

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.

Subject Code: AC-MT101E / AC-MT201E	**Category:** Audit Course
Subject Name: Disaster Management	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO4: 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.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	**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.	4
3	**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	4
4	**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.	4
5	**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	4

	for Survival.	
6	**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.	4
	Total number of contacts (Hr.)	24

Learning Resources:

1. S.C. Sharma, Disaster Management, Khanna Book Publishing Company
2. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
3. Sahni, Pardeep et.al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
4. Goel S. L. , Disaster Administration And Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

Subject Code: AC-MT101F / AC-MT201F	**Category:** Audit Course
Subject Name: Value Education	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Have knowledge of self-development.
CO2: Express himself as a refined personality.
CO3: Understand and respect the qualities of other beings.
CO4: Realize the essence of human values.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	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	6
2	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	6
3	Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking, Integrity and discipline. Punctuality, Love and Kindness, 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.	6
4	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	6
	Total number of contacts (Hr.)	24

Learning Resources:

1. Chakraborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi
2. Professional Ethics & Human Values, Khanna Book Publishing Company, Delhi.

Subject Code: AC-MT101G / AC-MT201G	**Category:** Audit Course
Subject Name: Stress Management by Yoga	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to
CO1: Sort out the source of stress and eliminate it.
CO2: Maintain a good health of body and mind.
CO3: Realize the greater purpose of existence.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Definitions of Eight parts of yog. (Ashtanga)	8
2	Yam and Niyam: Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	Asan and Pranayam i) Various yog poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects, Types of pranayams	8
	Total number of contacts (Hr.)	24

Learning Resources:

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

Subject Code: AC-MT101H / AC--MT201H	**Category:** Audit Course
Subject Name: Personality Development Through Life Enlightenment Skills	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Decide a proper life goal with higher purpose.
CO2: Establish his/her mind in stillness and focus in his/her actions.
CO3: Realize the greater purpose of existence.
CO4: Find the inspiration to dedicate his/her actions for the welfare of all.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Neetisatakam - Holistic development of personality • Verses- 19,20,21,22 (wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65 (virtue) • Verses- 52,53,59 (dont's) • Verses- 71,73,75,78 (do's)	8
2	• 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.	8
3	• 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: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	8
	Total number of contacts (Hr.)	24

Learning Resources:

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.
3. E. Balaguruswamy, Developing Thinking Skills, Khanna Book Publishing Company, Delhi

Subject Code: AC-MT101I / AC-MT201I	**Category:** Audit Course
Subject Name: Sanskrit for Technical Knowledge	**Semester**: I / II
L-T-P: 2-0-0	**Credit:** 0
Pre-Requisites: No-prerequisite	

Course Outcomes:

On successful completion of the course, students will be able to

CO1: Get a working knowledge in Sanskrit.
CO2: Learn this well-structured language to improve brain functioning.
CO3: Develop the logic in mathematics, science & other subjects enhancing the memory power.
CO4: Explore the huge knowledge from ancient literature.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences	8
2	Order, Introduction of roots, Technical information about Sanskrit Literature	8
3	Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics from ancient literature.	8
	Total number of contacts (Hr.)	24

Learning Resources:

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.