Mechanical Engineering

Semester -VII

Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	MEC701	Automation in Manufacturing	3	0	0	3
2	PEC-III		3	0	0	3
3	PEC-IV		3	0	0	3
4	OEC III		3	0	0	3
5	OEC IV		3	0	0	3
6	ME701P	Lab VII (RAC)	0	0	2	1
7	ME702D	Project-I	0	0	4	2
8	ME703I	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-III (Anyone)	Code	Professional Elective-IV (Any one)
MEP702	Refrigeration and Air Conditioning	MEP705	Power Plant Engineering
MEP703	Cryogenics	MEP706	Finite Element Analysis
MEP704	Gas Dynamics	MEP707	Tool Design

Code	Open Elective-III (Any one)	Code	Open Elective-IV(Any one)
MEO708	Mechanical Vibrations	MEO713	Rapid Prototyping
MEO709	Convective Heat Transfer	MEO714	Industrial Automation
MEO710	Micro and Nano Manufacturing	MEO715	Technology management
MEO711	Energy Systems and Management	MEO716	Computer Aided Manufacturing
MEO712	Condition Monitoring	MEO717	Maintenance Engineering & management

Semester -VIII

Branch: Mechanical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1	ME801D	Project-II			16	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Mechanical Engineering			
MEC701	**Automation in Manufacturing**	**L**	**T**
		3	**0**

Course Objectives:

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC.
3. To understand the basics of product design and the role of manufacturing automation

DETAILED SYLLABUS

Module 1

Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers. **(10)**

Module 2

NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing. **(6)**

Module 3

Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC Adaptive Control. **(10)**

Module 4

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies Introduction to Modeling and Simulation. **(6)**

Module 5

Product design, process route modeling, Optimization techniques, Case studies & industrial applications, Autonomous vehicles. **(10)**

Course Outcomes:

Upon completion of this course, the students will get a comprehensive picture of computer based automation of manufacturing operations.

Text Books:

i. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.
ii. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson.

Mechanical Engineering			
MEP702	**Refrigeration and Air Conditioning**	**L**	**T**
		3	**0**

Objectives:

1. To familiarize with the terminology associated with refrigeration systems and air conditioning 2. To understand basic refrigeration processes
3. To understand the basics of psychrometry and practice of applied psychrometrics
4. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

DETAILED SYLLABUS

Module 1

Classification of refrigeration systems: Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics - Ozone depletion and global warming issues - System components. **(10)**

Module 2

Compressors, Condensers, Expansion devices and Evaporators -Performance matching of components of refrigeration systems. **(8)**

Module 3

Advanced sorption refrigeration systems and their components. **(4)**

Module 4

Review of Psychrometry and Air-conditioning processes - Comfort air conditioning and Cooling load calculations. **(8)**

Module 5

Applications of AC systems - Concept of enthalpy potential – Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils. **(10)**

Course Outcomes:

A student who has done the course will have a good understanding of the working principles of refrigeration and air-conditioning systems.

Text Books:

1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill,1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

Mechanical Engineering			
MEP703	**Cryogenics**	**L**	**T**
		3	**0**

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

1. Understand principles of cryogenic systems.
2. Understand air and helium liquefaction processes.
3. Classify cascade refrigeration systems.
4. Understand principles of ultra-low temperature systems and their applications.
5. Evaluate storage systems used in cryogenic applications.

DETAILED SYLLABUS

Module 1

Introduction: Definition and Engineering Applications of Cryogenics, Properties of solids for cryogenic systems. **(5)**

Module 2

Refrigeration and Liquefaction: Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual-pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle. **(10)**

Module 3

Ultra-low-temperature refrigerators: Definition and Fundamentals regarding ultra-low-temperature refrigerators, Equipment associated with low-temperature systems, Various Advantages and Disadvantages. **(10)**

Module 4

Storage and Handling of Cryogenic Refrigerants: Storage and Transfer systems, Insulation, Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on. **(10)**

Module 5

Applications: Broad Applications of Cryogenic Refrigerants in various engineering systems. **(5)**

Text Books:

1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics - Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. Arora, C.P., Refrigeration and Air-conditioning, Tata-McGraw Hill, 2008.

Mechanical Engineering			
MEP704	**Gas Dynamics**	**L**	**T**
		3	**0**

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

1. Solve flow equations for quasi one dimensional flow through variable area ducts.
2. Analyze the flow through constant area ducts with friction and heat transfer.
3. Analyze flows with normal and oblique shocks.
4. Solve flow problems with supersonic velocities using shock-expansion theory.
5. Solve linearized velocity potential equation for multi-dimensional flows.

DETAILED SYLLABUS

Module 1

Introduction: Review of basic fluid dynamic and thermodynamic principles, Conservation equations for inviscid lows. **(10)**

Module 2

One Dimensional flow: One-dimensional wave motion, normal shock waves, Oblique shock waves, Prandtl-Meyer expansions and applications, Generalized one-dimensional flow Nozzle.

(10)

Module 4

Flow: Isentropic flow with area change, Flow with friction (Fanno flow), Flow with heat addition (Rayleigh flow), Method of characteristics (application to one-dimensional unsteady isentropic flow). **(10)**

Module 5

Supersonic Flow: Velocity Potential Equation, Numerical Techniques for Steady Supersonic Flow, Time Marching Technique for Supersonic Blunt Bodies and Nozzles. **(10)**

Text Books:

1. Anderson, J.D Jr., Modern Compressible Flows, Tata McGraw Hill, 2012.
2. Yahya, S.M., Fundamentals of Compressible Flow, New age International Pub., 2013.
3. Zucrow, M., Gas Dynamics, Wiley India, 2013.

Mechanical Engineering			
MEP705	**Power Plant Engineering**	**L**	**T**
		3	**0**

Objectives:
To provide an overview of power plants and the associated energy conversion issues.

DETAILED SYLLABUS

Module 1
Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems. **(10)**

Module 2
Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems. **(8)**

Module 3
Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants. **(10)**

Module 4
Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems Energy. **(5)**

Module 5
Economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants. **(10)**

Course Outcomes:
Upon completion of the course, the students can understand the principles of operation for different power plants and their economics.

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Mechanical Engineering			
MEP706	**Finite Element Analysis**	**L**	**T**
		3	**0**

Objectives:
1. To illustrate the principle of mathematical modeling of engineering problems
2. To introduce the basics and application of Finite Element Method

DETAILED SYLLABUS

Module1
Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method. **(10)**

Module2
One dimensional second order equation, discretization, linear and higher order elements,derivation of shape functions, Stiffness matrix and force vectors, assembly of elementalmatrices, solution of problems from solid mechanics and heat transfer, longitudinal vibrationand mode shapes, fourth order beam equation, transverse deflections and natural frequencies. **(12)**

Module3
Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors. **(6)**

Module 4
Application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Planestresses and plane strain problems, body forces and thermal loads, plate and shell elements. **(8)**

Module 5
Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software. **(6)**

Course Outcomes:
Upon completion of the course, students will understand the FEM formulation and itsapplication to simple structural and thermal problems

Text Books:

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.
3. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann,2004.
4. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.

Mechanical Engineering			
MEP707	**Tool Design**	**L**	**T**
		3	**0**

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

1. Interpret the geometrical and dimensional details of a production drawing.
2. Understand principles of locating and clamping systems.
3. Design jigs and fixtures for conventional and NC machining
4. Select and design progressive, compound or combination dies for press working operations
5. Design single point and multipoint cutting tools

DETAILED SYLLABUS

Module 1

Basic principles of tool design: Tool design – An overview, Introduction to Jigs and fixtures.

Work holding devices: Basic principle of six point location, Locating methods and devices, Principle of clamping and Types of clamps. (10)

Module 2

Design of jigs: Type of Drill bushes, Classification of drill jigs, Design of drill jigs. (3)

Design of fixtures: Design of milling fixtures, Design of turning fixtures (3)

Module 3

Introduction of press tool design: Introduction to Die cutting operations, Introduction to press and classifications, Die set assembly with components, Introduction to Centre of pressure, Examples of centre of pressure, Design of piercing die, Design of blanking die, Progressive, Compound and Combination dies . (10)

Module 4

Design of cutting tools: Introduction to cutting tools, Design of single point tool, Design of drill bit, Design of milling cutter (4)

Module 5

Brief introduction of NC machines work holding devices: Tool design for NC machines- An introduction, Fixture design for NC Machine, Cutting tools for NC Machine, Tool holding methods for NC Machine, ATC and APC for NC Machine, Tool presetting for NC Machine. (10)

Text Books:

1. F.W.Wilson.F.W. "Fundamentals of Tool Design", ASME, PHI, New Delhi, 2010

2. Donaldson.C, G.H.Lecain and V.C.Goold "Tool Design", TMH, New Delhi, 2010

Mechanical Engineering			
MEO708	**Mechanical Vibrations**	**L**	**T**
		3	**0**

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

1. Understand the causes and effects of vibration in mechanical systems.
2. Develop schematic models for physical systems and formulate governing equations of motion.
3. Understand the role of damping, stiffness and inertia in mechanical systems
4. Analyze rotating and reciprocating systems and compute critical speeds.
5. Analyze and design machine supporting structures, vibration isolators and absorbers.

DETAILED SYLLABUS

Module 1

Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models. (6)

Module 2

SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert's method, Energy method, (4)

Module 3

Free Vibration:: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation. (5)

Module 4

Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration. (6)

Module 5

Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion.

Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial

conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers. (10)

Module 6

Multi degree of freedom systems: Introduction , Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.

(6)

Module 7

Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method. (4)

Text Books:

1. L. Meirovich, Elements of Vibration analysis, 2nd Ed. Tata Mc-Grawhill 2007
2. Reference Books:
3. Singiresu S Rao, Mechanical Vibrations. 4th Ed. , Pearson education 2011
4. W.T., Thompson, Theory of Vibration. CBS Publishers
5. Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000

Mechanical Engineering			
MEO709	**Convective Heat Transfer**	**L**	**T**
		3	**0**

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

1. Understand principles of forced and free convection heat transfer processes.
2. Formulate and solve convective heat transfer problems.
3. Estimate heat dissipation from heat transfer devices.
4. Evaluate energy requirements for operating a flow system with heat transfer.
5. Understand current challenges in the field of convective heat transfer.

DETAILED SYLLABUS

Module 1

Introduction: Course structure, Basics of Thermodynamics, Fluid mechanics and Heat transfer
Fundamental Principles: Continuity, momentum and energy equations, Reynolds transport theorem, Second law of TD, Rules of Scale analysis, Concept of Heat line visualization. (8)

Module 2

Laminar forced convection: External flows: Boundary layer concept, velocity and thermal boundary layer, Governing equations, Similarity solutions, various wall heating conditions, Flow over sphere, wedge and stagnation flow. (8)

Module 3

Laminar forced convection: Internal flows: Fully developed laminar flow: Constant heat flux, Constant wall temperature, developing length. (4)
External Natural convection: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Boundary layer equations, Scale analysis, Low and high Prandtl number fluids, vertical walls, horizontal walls, sphere. (6)

Module 4

Internal Natural Convection: Natural convection in enclosures: isothermal and constant heat flux side walls, triangular enclosures, heated from below, inclined enclosures, annular space between horizontal cylinders. (8)

Module 5

Turbulent boundary layer flow: Boundary layer equations, mixing length model, flow over single cylinder, cross flow over array of cylinders, Natural convection along vertical walls, Turbulent duct flow. (6)

Text Books:

1. Bejan, A., Convection Heat Transfer, John Willey and Sons, New York, 2001.
2. Louis, C. Burmeister, Convective Heat Transfer, John Willey and Sons, New York, 2003.

3. Kays, W.M. and Crawford, M. E., Convective Heat and Mass Transfer, McGraw Hill, New York, 2001.

Mechanical Engineering			
MEO710	**Micro and Nano Manufacturing**	**L**	**T**
		3	**0**

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

1. Understand manufacturing considerations at the micro and nano scale.
2. Understand design-and-analysis methods and tools used for micro and nano manufacturing
3. Select manufacturing methods, techniques and process parameters for material processing quality
4. Design and select industrially-viable processes, equipment and manufacturing tools for specific industrial products

DETAILED SYLLABUS

Module 1

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches,, challenges in Nanotechnology.

Nanomaterials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing(GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing(GPC). (11)

Module 2

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). (9)

Module 3

Spectroscopic characterizations: Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy.

Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS). (10)

Module 4

Thermal Characterization of Nanomaterials: DTA, TGA, DSC (Principle and Applications), Determination of thermo physical parameters.

Microfabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding. MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining. (6)

Module 5

Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.

MEMS devices and applications: Pressure sensor, Inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems. (4)

Text Books:

1. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.
2. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
3. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005.
4. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc, New York, 1994. 5. B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice Hall , 2002.
5. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture,” McGraw- Hill, 2008.

Mechanical Engineering			
MEO711	**Energy Systems and Management**	**L**	**T**
		3	**0**

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

1. Understand principles of energy management and its influence on environment.
2. Comprehend methods of energy production for improved utilization.
3. Improve the performance of thermal systems using of energy management principles
4. Analyze the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems.
5. Evaluate energy projects on the basis of economic and financial criteria.

DETAILED SYLLABUS

Module 1

Introduction to Thermodynamics, Fluid Flow and Heat Transfer

Heat transfer media: Water, steam, Thermal fluids, Air-water vapour mixtures. (8)

Module 2

Heat transfer equipment: Heat exchangers, Steam plant

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energystorage systems (10)

Module 3

Energy conversion systems: Furnaces, turbines

Heat recovery systems: Incinerators, regenerators and boilers

Energy Management: Principles of Energy Management, Energy demand estimation, Organising and Managing Energy Management Programs, Energy pricing. (10)

Module 4

Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. (8)

Module 5

Economic Analysis: Scope, Characterization of an Investment Project, Case studies. (5)

Text Books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
4. Smith, C. B., Energy Management Principles, Pergamon Press, 2007.

Mechanical Engineering			
MEO712	**Condition Monitoring**	**L**	**T**
		3	**0**

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

1. Understand and apply maintenance schemes in industries.
2. Monitor condition of rotating machinery using signature, temperature and corrosion analysis.
3. Apply oil analysis technique to diagnose the wear debris.
4. Understand modern technologies for effective plant maintenance.

DETAILED SYLLABUS

Module 1

Introduction: Failures – System, component and services failures – classification and its causes, Maintenance Schemes – objectives – types and economic benefits, break down, preventive and predictive monitoring. (8)

Module 2

Vibration Monitoring – causes and effects of vibration, review of mechanical vibration concepts – free and forced vibrations, vibration signature of active systems – measurement of amplitude, frequency and phase. (5)

Module 3

Vibration monitoring equipment– vibration sensors (contact and non-contact type) –factors affecting the choice of sensors, signal conditioners, recording and display elements, vibration meter and analyzers, measurement of overall vibration levels. (6)

Module 4

Contaminant analysis: Contaminants in used lubricating oils – monitoring techniques (wear debris) – SOAP technique, Ferrography, X-ray spectrometry, Particle classification.

Temperature Monitoring – Various techniques – thermograph, pyrometers, indicating paint and NDT methods. (11)

Module 5

Special Techniques: Ultrasonic measurement method, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, critical speed analysis, shaft orbit analysis, Cepstrum analysis. Non-destructive techniques, Structural health monitoring weldments for surface and subsurface cracks. (10)

Text Books:

1. Rao J. S., Vibration Condition Monitoring, Narosa Publishing House, 2/e 2000.
2. Isermann R., Fault Diagnosis Application, Springer-Verlag Berlin, 2011.
3. Allan Davis, Hand book of Condition Monitoring, Chapman and Hall, 2000.
4. Choudary K K., Instrumentation, Measurement and Analysis, Tata McGraw Hill.
5. Collacott, R. A., Mechanical Faults Diagnosis, Chapman and Hall, London, 1990

Mechanical Engineering			
MEO713	**Rapid Prototyping**	**L**	**T**
		3	**0**

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

1. Identify suitable time compression techniques for rapid product development.
2. Model complex engineering products and develop process plans for rapid production.
3. Analyse and select a rapid manufacturing technology for a given component.
4. Identify the errors during generation of STL files and minimize them.
5. Optimize FDM process parameters to improve the quality of the parts.

DETAILED SYLLABUS

Module 1

Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. (5)

Module 2

RP Software: Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

Photopolymerization RP Processes: Stereolithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photopolymerization Processes. (9)

Module 3

Powder Bed Fusion RP Processes: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.

Extrusion-Based RP Systems: Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes. (6)

Module 4

Printing RP Processes: 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes.

Sheet Lamination RP Processes: Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. (6)

Module 5

Beam Deposition RP Processes: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks.
Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. (6)

Module 6

Reverse Engineering: Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.
Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc.
RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP. (6)

Text Books:

1. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.
2. Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
3. RafiqNoorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

Mechanical Engineering			
MEO714	**Industrial Automation**	**L**	**T**
		3	**0**

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

1. Enumerate principles, strategies and advantages of industrial automation.
2. Select level of automation and calculate manpower requirement.
3. Design material handling and material storage systems for an automated factory.
4. Automate shop floor controls and part/device identification methods.
5. Study the effect of automation by simulation and experimentation.

DETAILED SYLLABUS

Module 1

Principles and Strategies of Automation-Power to Accomplish the Automated Process, program of Instruction, Control System, Advanced automation Functions-safety Monitoring, maintenance and repair Diagnostics, error Detection and Recovery, levels of automations-Five levels of automation and control in manufacturing. (10)

Module 2

Material Handling systems and Design-Introduction to Material Handling, Material Transport Equipment, analysis of Material Transport Systems, Storage systems-Storage System Performance and Location Strategies, Conventional Storage Methods and Equipment. (10)

Module 3

Automation Storage Systems, Engineering Analysis of Storage Systems.

Automatic identification methods-Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies. (6)

Module 4

Industrial control systems-Process Industries Vs Discrete Manufacturing Industries, Levels of Automation in the two industries, Variables and Parameters in the two industries.

Continuous Vs Discrete control- Continuous Control System, Discrete Control System.

Computer process control and its forms- Control Requirements, Capabilities of Computer Control, and Forms of Computer process Control. (10)

Module 5

Control system components-Sensors, Actuators, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Input/output Devices for Discrete Data. (4)

Text Books:

1. Groover, M.P., Automation production Systems and Computer Integrated Manufacturing, Pearson Education, 2003.
2. Krishna Kant, Computer Based Industrial Control, Prentice Hall of India, New Delhi, 2000.
3. Tiess Chiu Chang and Richard A.W., An Introduction to Automated Process planning Systems, Tata McGraw-Hill Publishing company, New Delhi, 2000.

Mechanical Engineering			
MEO715	**Technology Management**	**L**	**T**
		3	**0**

Objectives: In the Management of Technology programme the students learn to explore andunderstand technology as a corporate resource - a resource that allows a firm to keep many differentballs in the air. It shows how firms can use technology to design and develop products and servicesthat maximize customer satisfaction on the one hand, while maximizing corporate productivity,profitability and competitiveness on the other.

Outcomes: The programme addresses challenging questions most companies face such as:

1. What technologies do we need and when?
2. Do we procure the technology we need with our own research capabilities, in collaborationwith outside parties, or by acquiring it or licensing it from others?
3. How can we use the abundant technological opportunities to affect our mission, objectives and strategies?

DETAILED SYLLABUS

Module 1: Introduction to Technology Management

Definition, Concept of creativity, Components, Features, Classification of Technology, Concept andNature of Technology Management, Drivers of MOT, Significance and Scope of MOT, Role ofChief Technology Officer, Responding to Technology challenges. (8)

Module-2: The Role of Technology in the Creation of Wealth

The creation of wealth, Long-wave cycle, Evolution of production technology, Critical Factors inManaging Technology: The creativity factor, Types of innovation, Technology, price relationship,Managing change. (6)

Module 3: Management of Technology

The New Paradigms Essential issues in technology management, Project planning and management,Management paradigm and the technology factor. (4)

Module-4: Technology Life Cycles

S-curve of technological progress, Multiple generation technologies ,Diffusion of technology (2)

Module-5: The Process of Technological Innovation

Innovation and creative transformation in the knowledge age: critical trajectories, Case-Xerox, Amodel for technological innovation in biomedical devices. (5)

Module-6: Strategic planning

Competitiveness, Business Strategy and Technology Strategy, Technology Planning. TheAcquisition and Exploitation of Technology: Acquisition of technology. Exploitation of technology,Stages of technology development, Technology Transfer (6)

Module-7: Technology Diffusion

Concept of Diffusion, Integrated Diffusion Strategy, Influencing factors, Innovation adoption, Diffusion strategies, Community effects and network externalities, Distribution of Adopters,Crossing the Chasm, Market dynamics.Technology Absorption and Deployment, Technology Absorption, Influencing factors, Deploymentstrategies, Corporate Venturing, Benefits and Drawbacks of Corporate Venturing, Spin-offCompanies. (9)

Text Book:

1. Management of Technology by Tarek Khalil.
2. Rastogi P.N: "Management of Technology and Innovation", Sage Publications, New Delhi, 2009.
3. Scott Shane: "Technology Strategy for Managers and Entrepreneurs", Pearson Education, New Delhi, 2009.
4. CSG Krishnamacharyulu, Lalitha Ramakrishnan, "Management of Technology", Himalaya, Publishing House Private Limited, New Delhi, 2008.

Mechanical Engineering			
MEO716	**Computer Aided Manufacturing**	**L**	**T**
		3	**0**

Objectives

1. This course introduces students with computer assisted modern manufacturing technologies.
2. The objective of this course is to make students learn the important theoretical concepts, and the state-of-the-art technological developments in the area of modern manufacturing.
3. Various topics to be covered are basics of automation, NC programming (Manual and APT),
4. concepts of group technology, Flexible Manufacturing system, CIM and robotics.

Outcomes: Student will be able to:

1. Understand the current status of CAM systems in industry.
2. Learn the concepts of group technology, automation, FMS and CIM.
3. To write manual part programs using G and M codes for lathe and milling m/c.
4. To write APT part programs milling m/c.

DETAILED SYLLABUS

Module 1

Automation: Definition of Automation, Need for Automation, building block of automationtechnology, Types of automation systems, Automation strategies, levels of automation, types of control system, Advantages, Disadvantages and applications of Automation. (8)

Module 2

NC, CNC and Adaptive control: Introduction, history, components of NC machines, classificationof NC machines, input media for NC machines, microprocessor based CNC systems, block diagramof a typical CNC system, features of CNC, advantages of CNC, direct numeric control (DNC) and itsadvantages, Adaptive control and its types. (10)

Module 3

Part programming: Introduction, NC coordinate system, fixed and floating zero machines, NC motion control systems, part programming methods, Manual part programming for milling and latheusing G and M codes, various canned cycles, Computer aided part programming: Introduction toAPT language, simple problems on APT programming. (10)

Module 4

Group Technology: Introduction, part families, part classification and coding, production flow analysis, composite part concept, machine cell design, benefits of GT. (4)

Module 5

FMS and CIM: Concept and definition of Flexible Manufacturing System (FMS), components ofFMS, FMS workstations, Automated material handling and storage systems, Automated storage andretrieval system and Industrial robots, FMS layout and benefits, Introduction and concept ofComputer Integrated manufacturing (CIM) through CIM wheel. (8)

Text books:

1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
2. Kundra, Rao and Tiwari., Computer Aided manufacturing, Tata McGraw Hill Publishers.

Reference books:

1. Steve Krar, Arthur Gill, “CNC technology and programming”, McGraw-Hill, 1990
2. James Madison, “CNC machining hand book”, Industrial Press Inc., 1996
3. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.
4. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall.

Mechanical Engineering			
MEO717	**Maintenance Engineering & Management**	**L**	**T**
		3	**0**

Objectives:

1. To keep asset in productivity and availability state based on requirement level of reliability and effectiveness.
2. To spend optimal maintenance cost in relation to achieve the availability and effectiveness of equipments.
3. To prevent or reduce the likelihood or frequency of failures of engineering components and systems.
4. To increase the quality, quantity of the product with minimal cost and increase the productivity of the plant.
5. To identify and correct the causes of failures that does occur in engineering system.

Outcomes: Student will be able to:

1. Maintenance management skill
2. Need of safety devices
3. Increase the productivity of the plant at minimal cost
4. Failure analysis of plant machineries
5. Concept of tribology, conditioning monitoring
6. Concept of maintainability and availability of mechanical components and systems.

DETAILED SYLLABUS

Module 1

Introduction: Fundamentals of Maintenance Engineering, Maintenance engineering its importance in material &energy conservation, Inventory control, Productivity, Safety, Pollution control, Safety Regulations,Pollution problems, Human reliability. (8)

Module 2

Maintenance Management: Types of maintenance strategies, Planned and unplanned maintenance, Breakdown, Preventive &Predictive maintenance their comparison, Computer aided maintenance, Maintenance scheduling,Spare part management, Inventory control, TPM. (8)

Module 3

Tribology In Maintenance: Friction wear and lubrication, Friction & wear mechanisms, Prevention of wear, Types of lubricationmechanisms, Lubrication processes. Lubricants types, General and special purpose, Additives,Testing of lubricants, Degradation of lubricants, Seal & packing. (8)

Module 4

Machine Health Monitoring: Condition based maintenance, Signature analysis, Oil analysis, NDT, Vibration, Noise and thermalsignatures, On line & off line techniques, Instrumentation &

equipment used in machine healthmonitoring. Instrumentation in maintenance, Signal processing, Data acquisition and analysis,Application of intelligent systems, Data base design.

(8)

Module 5

Reliability, Availability & Maintainability (RAM) Analysis: Introduction to RAM failure mechanism, Failure data analysis, Failure distribution, Reliability ofrepairable and non-repairable systems, Improvement in reliability, Reliability testing, Reliabilityprediction, Utilization factor, System reliability by Monte Carlo Simulation Technique. (8)

Text Books:

1. Krishnan Gopal and Banerji S. K., Maintenance & Spare parts Management, PHI
2. Mishra R. C. and Pathak K., Maintenance Engineering and Management, PHI
3. Shrivastava S.K., Industrial Maintenance Management, S. Chand Publications.
4. Rao C. N. R., Handbook of Condition Monitoring,.
5. Banga and Sharma, Industrial Engineering & Management Science, Khanna Publishers.

Reference Books:

1. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Hand Book, Mc-Graw Hill, 7th edition.
2. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Standard Hand Book, Mc-Graw Hill, 6th edition