# Vignana Bharathi Institute of Technology, Aushapur, Ghatkesar

## R21- B. Tech MECHANICAL ENGINEERING

### B.TECH-IV YEAR– I SEMESTER

| Sl.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **1** | 21MB4112 | Fundamentals of Management And Organizational Behavior | HS | 3 | - | - | 3 |
| **2** | 21ME4111 | Additive Manufacturing Technology | PC | 3 | - | - | 3 |
| **3** | | **Open Elective - III** | OE | 3 | - | - | 3 |
| **4** | | **Professional Elective–III** | PE | 3 | - | - | 3 |
| | 21ME4171 | Computational Fluid dynamics | | | | | |
| | 21ME4172 | Operations research | | | | | |
| | 21ME4173 | CNC technology | | | | | |
| | 21ME4174 | Engineering Tribology | | | | | |
| **5** | | **Professional Elective–IV** | PE | 3 | - | - | 3 |
| | 21ME4175 | Refrigeration and Air conditioning system | | | | | |
| | 21ME4176 | Renewable Energy Sources | | | | | |
| | 21ME4177 | Advanced Materials Technology | | | | | |
| | 21ME4178 | Robotics | | | | | |
| **6** | 21ME4151 | Additive Manufacturing Technology Laboratory | PC | - | - | 3 | 1.5 |
| **7** | 21ME4152 | Instrumentation & Control Systems Laboratory | PC | - | - | 3 | 1.5 |
| **8** | 21ME4181 | **Mini project** | PW | - | - | 4 | 2 |
| **Total** | | | | **15** | **-** | **10** | **20** |

### B.TECH– IVYEAR–II SEMESTER

| Sl.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **1** | | **Professional Elective-V** | PE | 3 | - | - | 3 |
| | 21ME4271 | Automation in Manufacturing | | | | | |
| | 21ME4272 | Mechanical Vibrations | | | | | |
| | 21ME4273 | Design of Experiments | | | | | |
| | 21ME4274 | Welding Technology | | | | | |
| **2** | | **Professional Elective–VI** | PE | 3 | - | - | 3 |
| | 21ME4275 | Machine tool design | | | | | |
| | 21ME4276 | Gas turbines for power and propulsion | | | | | |
| | 21ME4277 | Non-Destructive Testing | | | | | |
| | 21ME4278 | Production planning & control | | | | | |
| **3** | **21ME4282** | **Major Project** | PW | - | - | 20 | 10 |
| **Total** | | | | **6** | **-** | **20** | **16** |

## 21MB4112: FUNDAMENTALS OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR

**B.Tech IV Year I Sem**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Objective**:

- To understand the fundamentals of management, history and evolution of management theories
- To analyze various dimensions of organizational planning and organizing.
- To understand the functions of staffing, Directing and controlling.
- To understand the fundamental concepts of Organizational Behaviour.
- To analyze and evaluate the various dimensions of Cognitive process and Stress related issues in Organizational Behaviour.

**Course Outcomes:** After the completion of the course, student should be able to

- Understand the fundamentals of management and contribution of management thinkers.
- Analyze the relevance and importance of planning and organizing.
- Understand the importance of organizing, types of organizational structures and various function of human resource management
- Understand fundamental concepts of organizational behaviour
- Analyze and evaluate the various dimensions of cognitive process and stress related issues in organizational behaviour.

**UNIT- I**

**Introduction to Management**: Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of Management.

**Approaches**- Classical Scientific and Administrative Management; The Behavioral approach; The Quantitative approach; The Systems Approach; Contingency Approach, IT Approach.

**UNIT – II**

**Planning and Organizing**: General Framework for Planning - Planning Process, Types of Plans, Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization, Recentralization.

**UNIT- III**

**Staffing:** Functions of HRM.

**Leadership**: Leadership Styles; Leadership theories.

**Motivation** - Types of Motivation; Motivational Theories - Needs Hierarchy Theory, Two Factor Theory, Theory X, Theory Y and Theory Z.
**Communication:** Types of communication, Importance, Communication Process and communication Barriers.
**Controlling:** Process of controlling, Types of Control

**UNIT- IV**
Introduction to OB - Definition, Nature and Scope –Environmental and organizational context – Impact of IT, globalization, Diversity, Ethics, culture, reward systems and organizational design on Organizational Behaviour. Cognitive Processes-I : Perception and Attribution: Nature and importance of Perception – Perceptual selectivity and organization -Social perception – Attribution Theories.

**UNIT- V**
Cognitive Processes-II: Personality and Attitudes - Personality as a continuum – Meaning of personality - Johari Window and Transactional Analysis - Nature and Dimension of Attitudes- Stress and Conflict: Meaning and types of stress –Meaning and types of conflict - Effect of stress and intra-individual conflict - strategies to cope with stress and conflict.

**TEXT BOOKS**:


1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.
2. Fundamentals of Management, Stephen P. Robbins, Pearson Education, 2009
3. Principles and Practice of Management, L. M. Prasad, S. Chand, 2019, New Delhi.
4. Robbins, P. Stephen, Timothy A. Judge: Organisational Behaviour, 12/e, PHI/Pearson, NewDelhi, 2009.


## REFERENCES:


1. Newstrom W. John & Davis Keith, Organisational Behaviour-- Human Behaviour at Work, 12/e,TMH, New Delhi, 2009.
2. Luthans, Fred: Organizational Behaviour 10/e, McGraw-Hill, 2009.

## 21ME4111: ADDITIVE MANUFACTURING TECHNOLOGY

**B.Tech. IV Year –I Sem** **L T P C**
**3 0 0 3**

**Pre-Requisites**: Machining & Machine Tools Technology

**Course Objectives:** To learn

1. Explain the basic concepts of Additive Manufacturing, its advantages and limitations.
2. Classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc
3. Interpret the applications of these manufacturing technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc.
4. To Know Rapid prototyping Data formats
5. Build the potential of additive manufacturing concepts in different industrial sectors.

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

1. Explain the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing technologies.
2. Analyze suitable process and materials used in Additive Manufacturing.
3. Solve typical problems on reverse engineering for surface reconstruction from physical prototype models.
4. Apply technique of CAD for geometry transformation in Additive Manufacturing.
5. Apply knowledge of additive manufacturing for various real-life applications.

**UNIT I**

**Introduction:** Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages, and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain.

**UNIT II**

**Liquid-based Rapid Prototyping Systems:** Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, applications, Advantages and Disadvantages, Case studies.

**Solid-based Rapid Prototyping Systems:** Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modelling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

**UNIT III:**

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

**Rapid Tooling:** Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling : Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

**UNIT IV**

**Rapid Prototyping Data Formats:** STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software‟s: Features of various RP software‟s like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

**UNIT V**

**RP Applications** : Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Bio molecules.

**TEXT BOOKS**:

1. Brent Stucker, David Rosen, Ian Gibson " Additive Manufacturing Technologies" Handcover,Springer,2010.
2. Chua C.K., Leong K.F. and Chu SingLim,"Rapid Prototyping: Principles and Applications ", 3rd Edition,World Scientific Publishing Co Pte Ltd,2010

**REFERENCES:**

1. Terry Wohlers, Wholers Report 2000, Wohlers Associates.
2. Rapid Prototyping and Manufacturing /PaulF.Jacobs/ASME
3. Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
4. Amit Bandyopadhyay, Additive Manufacturing, CRC Press 2015.

**21ME4171: COMPUTATIONAL FLUID DYNAMICS**
**(PROFESSIONAL ELECTIVE – III)**

**B.Tech. IV Year –I Sem** **L T P C**
**3 0 0 3**

**Pre Requisites-** Fluid Mechanics, Mathematics.

**Course Objectives:**

1. To develop an understanding for the major theories, approaches and methodologies used in CFD
2. To build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.) in using commercial CFD codes
3. To gain experience in the application of CFD analysis to real engineering designs.
4. To find Finite difference applications in heat transfer
5. To understand Applications of CFD

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

1. Understand and be able to numerically solve the governing equations for fluid flow
2. Understand and apply finite difference, finite volume and finite element methods to fluid flow problems
3. Understand how to assess stability and conduct a grid-convergence assessment
4. Understand and apply compressible flow solvers
5. Understand the issues surrounding two-phase flow modeling

**Unit-I**

**Equations of fluid dynamics** Basic concepts Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity. Laws governing fluid motion, continuity, Navier – stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli‟s equation and vorticity transport equation. Initial and boundary conditions. Classification of equation of motions – hyperbolic, parabolic, elliptic.

**Unit-II**

**Mathematical Preliminaries** Numerical integration. Review of linear algebra, solution of simultaneous linear algebraic equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems; Gauss- Sidel method, successive over relaxation method.

**Unit-III**

**Grid Generation** Transformation of coordinates. General principles of grid generation – structured girids in two and three dimensions, algebraic grid generation, differential equations based grid generation; Elliptic grid generation, algorithm, Grid clustering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. Techniques for complex and large problems: Multi block methods.

**Unit-IV**

**Finite difference discretization** Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis. Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling- conservative property, upwind scheme, transporting property, higher order upwinding. Finite difference applications in heat transfer – conduction, convection.

**Unit-V**

**Finite Volume Method** Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretised equations using TDMA.Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Finite Element Method: Introduction. Weighted residual and variational formulations. Interpolation in one-dimensional and two-dimensional cases. Application of FEM to ID and 2D problems in fluid flow and heat transfer

**TEXT BOOKS:**

1. Ferziger J. H., Springer P.M, "Computational Methods for fluid Dynamics", Verlag Berlin
2. Anderson J. D. JR, "Computational fluid Dynamics", Mc Graw Hill Inc, 1995

**REFERENCES:**

1. Patankar S. P, "Numerical Heat Transfer & Fluid flow"
2. Sunderarajan M.K., "Computational Fluid Flow and Heat Transfer", 2nd Ed. 3.Computational Fluid Flow and Heat Transfer – K Muralidharan and T Sudarajan.
4. Computational Fluid Dynamics : The basics with applications – John D Anderson,McGraw Hill

**21ME4172: OPERATIONS RESEARCH**
**(PROFESSIONAL ELECTIVE – III)**

**B.Tech. IV Year –I Sem** **L T P C**
**3 0 0 3**

**Course Objectives:**

1. To define scientific approach to problem solving for executive management.
2. To illustrate modern methods to complex problems.
3. To solve the assignment problem helps us to maximize our profit or minimize the cost.
4. To develop game theory in which ones choice of action is determined after taking into account all possible alternatives.
5. To build inventory models for solving the inventory problems.

**Course Outcomes:**

At the end of the course, the students will able to

1. List out various Operation Research models and Illustrate linear programming problem.
2. Calculate transportation cost for a various transportation models.
3. Assess the inventory requirements and find best replacement period for machines under different conditions.
4. Construct a dynamic programming model.
5. Decide the number of servers to minimize waiting time of customers and idle time of a server.

**UNIT – I**

**Development:** History, Definition, OR Models, OR Techniques and phases of implementing OR in practice.

**Allocation**: Introduction to linear programming formulation, graphical solution, Simplex method, artificial variable technique, Un restricted Variables, Duality principle, Dual Simplex method.

**UNIT – II**

**Transportation Problem:** Formulation – Optimal solution, unbalanced transportation problem – Degeneracy. **Assignment problem** – Formulation – Optimal solution - Variants of Assignment Problem- Traveling Salesman problem.

**UNIT – III**

**Sequencing:** Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines – Job shop sequencing – two jobs through „m" machines

**Replacement:** Introduction – Replacement of items that deteriorate with time – when money value is not counted and counted – Replacement of items that fail completely- Group Replacement.

**UNIT – IV**

**Theory of Games:** Introduction –Terminology– Solution of games with saddle points and without saddle points- 2 x 2 games – dominance principle – m x 2 & 2 x n games –graphical method.

**Inventory:** Introduction – Single item, Deterministic models – Purchase inventory models with finite & infinite with one price break and multiple price breaks ,Models with shortages – Stochastic models – demand may be discrete variable or continuous variable – Single Period model and no setup cost.

**UNIT – V**

**Queuing Theory:** Introduction – Terminology-Single Channel – Poisson arrivals and Exponential Service times – with infinite population and finite population models– Multi channel – Poisson arrivals and exponential service times with infinite population. Machine Repair Model, Networks of Queues.

**Dynamic Programming:** Introduction – Terminology- Bellman‟s Principle of Optimality – Applications of dynamic programming- shortest path problem – linear programming problem.

**TEXT BOOKS:**

1. J.K.Sharma, “Operation Research”, MacMilan, 4th Ed., 2009, ISBN Number: 978-9350593363.
2. R.Pannerselvam, “Operations Research”, PHI Publications, 2nd Ed. Jan. 2006, ISBN Number: 978-8120329287.

**REFERENCES:**

1. Panneerselvam.R, “Operations Research”.
2. Belgundu, Ashok.D&Chandrupatla, Trupathi.R, “Optimization Concepts and Applications”.
3. Operations Research / S. D sharma
4. Operations Research / Er. Prem Kumar Gupta / Dr.D.S Hira / S.Chand

**21ME4173: CNC TECHNOLOGY**
**(PROFESSIONAL ELECTIVE – III)**

**B.Tech. IV Year –I Sem** **L T P C**
**3 0 0 3**

**Pre-Requisites:** Machine Tools

**Course Objectives:**
1. To know the structure and fundamentals of CNC machines
2. To learn various tooling methods and facilities in CNC machines.
3. To understand various controlling methods.
4. To demonstrate part programs techniques
5. To discuss latest advances in the manufacturing perspectives with PLC circuits.

**Course Outcomes:** At the end of the course Student will be able to
1. Apply the fundamentals of manufacturing techniques.
2. Develop part programs with G codes and M codes for typical components
3. Develop part programs with APT language
4. Understand the elements of an automated manufacturing environment
5. Apply the PLC to get more accurate results.

**UNIT I**
**Introduction to Computer Aided Manufacturing (CAM):** Features of NC machines fundamentals of numerical control, advantage of NC systems, classification of NC systems, point to point, NC and CNC, incremental and absolute, open and closed loop systems, features of NC Machine tools, design consideration of NC machine tool, methods of improving machine accuracy.
CNC Machine elements: machine structures - Guide ways - feed drives-spindles- spindle Bearings-measuring systems- tool mentoring systems.

**UNIT II**
**CNC Tooling and controlling systems**: Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, and quick change tooling system, automatic head changers. Introduction to FANUC, SINUMERIC controllers, CNC Machining Centers, CNC turning centers.

**UNIT III**
**CNC Programming:** NC part programming: manual programming-Basic concepts, point to point contour programming, canned cycles, parametric programming.

**Computer-Aided Programming:** General information, APT programming, Examples Apt programming problems (2D machining only). NC programming on CAD/CAM systems, the design and implementation of post processors. Introduction to CAD/CAM software, Automatic Tool Path generation.

**UNIT IV**

**DNC Systems and Adaptive Control:** Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, adaptive control with constraints, Adaptive control of machining processes like turning, grinding.

**UNIT V**

**Micro Controllers:** Introduction, Hardware components, I/O pins, ports, external memory, counters, timers and serial data I/O interrupts selection of Micro Controllers, Embedded Controllers, Applications and Programming of Micro Controllers.
**Programming Logic Controllers (PLC'S):** Introduction, Hardware components of PLC, system, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC"S in CNC Machines.

**TEXT BOOKS**:
1. Yoram Koren "Computer Control of Manufacturing Systems "McGraw Hill, New Edition, 2020.
2. Mattson "CNC Programming: Principles and Applications" Cengage, New Edition, 2020.
3. Michael Fitzpatrick "Machining and CNC Technology" 3rd Edition, McGraw Hill- Education 2013.

**REFERENCES:**
1. T.C. Chang, R.A. Wysk, H.P. Wang "Computer Aided Manufacturing", 3rd Edition, Pearson Prentice Hall, 2006.
2. Mikell P Groover "Automation, production system and computer aided manufacturing" Pearson, Fourth edition, 2018.
3. Warren S Seames" Computer Numerical control concepts and programming" 4th edition, Cengage Learning, 2018.
4. A K Roy, K M Bhurchandi" Advanced Microprocessors and peripherals" 2nd Edition, Tata McGraw Hill Education- 2006.

**21ME4174: ENGINEERING TRIBOLOGY**
**(PROFESSIONAL ELECTIVE – III)**

**B.Tech. IV Year –I Sem** **L T P C**
**3 0 0 3**

**Pre-Requisites:**
Engineering Mechanics, Kinematics of Machines, Design of Machine Members.

**Course Objectives:**
1. To educate the students on the importance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants.
2. To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.
3. To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
4. To expose the students to the factors influencing the selection of bearing materials for different sliding applications.
5. To introduce the concepts of surface engineering and its importance in tribology.

**Course Out comes:** At the end of this course, the student will be able to:
1. Understand the fundamentals of tribology and associated parameters.
2. Apply concepts of tribology for the performance analysis and design of components experiencing relative motion.
3. Analyze the requirements and design hydrodynamic journal and plane slider bearings for agiven application.
4. Select proper bearing materials and lubricants for a given tribological application.
5. Apply the principles of surface engineering for different applications of tribology.

**UNIT I**
**Introduction to Tribology:** Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants, viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

**UNIT II**
**Friction:** Origin, friction theories, measurement methods, friction of metals and non-metals Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

**UNIT III**
**Hydrodynamic journal bearings:** Friction forces and power loss in a lightly loaded journal bearing, Petroff‟s equation, mechanism of pressure development in an oil film, and Reynold‟s equation in 2D. Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld‟s number and its significance; partial bearings, end leakages in journal bearing, numerical examples on full journal bearings only.

**UNIT IV**

**Plane slider bearings with fixed/pivoted shoe:** Pressure distribution, Load carrying capacity, Co efficient of friction, frictional resistance in a fixed/pivoted shoe bearing centre of pressure, numerical examples.

**Hydrostatic Lubrication:** Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples.

**UNIT V**

**Bearing Materials:** Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials. Introduction to Surface engineering: Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance.

**TEXT BOOKS**:

1. B. Bhushan, "Introduction to Tribology" John Wiley & Sons, Inc., New York, 2002.
2. Prasanta Sahoo, "Engineering Tribology" PHI Learning Private Ltd, New Delhi, 2011.

**REFERENCES:**

1. B. C. Majumdar, "Introduction to Tribology in bearings" Wheeler Publishing
2. J. A. Williams"Engineering Tribology" Oxford Univ. Press, 2005.
3. G. W. Stachowiak and A.W. Batchelor "Engineering Tribology" Butterworth-Heinemann,1992.
4. Ernest Rabinowicz, "Friction and Wear of Materials" John Wiley & sons,1995.
5. B .Bhushan, B.K. Gupta, "Handbook of tribology: materials, coatings and surface treatments" McGraw-Hill,1997.

**21ME4175: REFRIGERATION AND AIR CONDITIONING**
**(PROFESSIONAL ELECTIVE – IV)**

**B.Tech. IV Year –I Sem** **L T P C**
**3 0 0 3**

**Pre-requisite**: Thermodynamics

**Course Objective**:

1. To provide a fundamentals of refrigeration and air conditioning, psychrometry
2. To accustom with various methods of production of cold
3. To impart knowledge about applications of refrigeration and air conditioning
4. To familiarize with industrial protocols, regulations in the field
5. To Familiarize with Air conditioning Process

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

1. Understand the principles and remember the applications of refrigeration systems
2. Analyze performance of vapor compression refrigeration system
3. Analyze the air conditioning processes using principles of Psychrometry
4. Study the working principles of vapor absorption, thermoelectric, steam jet refrigeration system.
5. Evaluate cooling and heating loads in an air conditioning system. Create capacity to compute heating /cooling load.

**UNIT – I**

**Introduction to Refrigeration**: - Necessity and applications – Unit of refrigeration and C.O.P. – Mechanical Refrigeration – Types of Ideal cycle of refrigeration. Air Refrigeration: Bell Coleman cycle and Brayton Cycle, Open and Dense air systems – Actual air refrigeration system – Refrigeration needs of Air crafts- Air systems – Application of Air Refrigeration, Justification – Types of systems – Problems.

**UNIT – II**

**Vapour compression refrigeration** – working principle and essential components of the plant – Simple Vapour compression refrigeration cycle – COP – Representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – Actual cycle Influence of various parameters on system performance – Use of p-h charts – Problems.

**UNIT - III**

**System Components**: Compressors – General classification – comparison – Advantages and Disadvantages. Condensers – classification – Working Principles. Evaporators – classification – Working Principles. Expansion devices – Types – Working Principles. Refrigerants – Desirable properties – common refrigerants used – Nomenclature – Ozone Depletion – Global Warming – Azeotropes and Zeotropes.

**UNIT - IV**

**Vapor Absorption System** – Calculation of max COP – description and working of NH3 – water system – Li – Br system. Principle of operation Three Fluid absorption system, salient

features. Steam Jet Refrigeration System – Working Principle and Basic Components Principle and operation of (i) Thermoelectric refrigerator (ii) Vortex tube or Hilsch tube.

**UNIT – V**

**Introduction to Air Conditioning**: Psychometric Properties & Processes – Sensible and latent heat loads – Characterization – Need for Ventilation, Consideration of Infiltration – Load concepts of RSHF, ASHF, ESHF and ADP. Concept of human comfort and effective temperature –Comfort Air conditioning – Industrial air conditioning and Requirements – Air conditioning Load Calculations. Air Conditioning systems - Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, deodorants, fans and blowers. Heat Pump – Heat sources – different heat pump circuits – Applications.

**TEXT BOOKS:**

1. CP Arora "Refrigeration and Air conditioning", Mc Graw Hill 2015
2. RC Aora "Refrigeration and Air-Conditioning", PHI 2012

**REFERENCES**:

1. Dossat"Principles of Refrigeration" Pearson
2. Anantha narayanan "Basic Refrigeration and Air-Conditioning" Mc Graw Hill
3. Manohar Prasad "Refrigeration and Air conditioning" New Age International publishers, New Delhi.
4. Stocker W.S., "Refrigeration & Air Conditioning", McGraw Hill, New Delhi, 2004.

**21ME4176: RENEWABL ENERGY SOURCES**
**(PROFESSIONAL ELECTIVE – IV)**

**B.Tech. IV Year –I Sem** **L T P C**
**3 0 0 3**

**Course Objectives:**

1. To explain the concepts of Non-renewable and renewable energy systems
2. To outline utilization of renewable energy sources for both domestic and industrial applications
3. To analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.
4. To Understand Principles of Wind Energy
5. To Know the Fundamentals of Biogas and Ocean Energy

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

1. Recognize the importance of Solar Energy.
2. Identify need of solar collectors and their storage.
3. Discuss the potential usage of Wind and Biomass energy.
4. Explain the sources and usage of Geo thermal and tidal energy.
5. Classify the sources of direct energy conversion Systems.

**UNIT I**

**Global and National Energy Scenario:** Over view of conventional & renewable energy sources, need & development of renewable energy sources, types of Renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Renewable and Non-renewable Energy sources, Energy for sustainable development, Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy- Concept of Hybrid systems.

**UNIT II**

**Solar Energy:** Solar energy system, Solar Radiation, Availability, Measurement and Estimation, Solar Thermal Conversion Devices and Storage, Applications Solar Photovoltaic Conversion solar photovoltaic, solar thermal, applications of solar energy systems.

**UNIT III:**

**Wind Energy:** Wind Energy Conversion, Potential, Wind energy potential measurement, Site selection, Types of wind turbines, Wind farms, wind Generation and Control. Nature of the wind, power in the wind, factors influencing wind, wind data and energy estimation, wind speed monitoring, classification of wind, characteristics, applications of wind turbines, offshore wind energy – Hybrid systems, wind resource assessment, Betz limit, site selection, wind energy conversion devices. Wind mill component design, economics and demand side management, energy wheeling, and energy banking concepts. Safety and environmental aspects, wind energy potential and installation in India.

**UNIT IV**

**Biogas:** Properties of biogas (Calorific value and composition), biogas plant technology and status, Bio energy system, design and constructional features. Biomass resources and their classification, Biomass conversion 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.

**UNIT V**

**Ocean Energy:** Ocean wave energy conversion, principle of Ocean Thermal Energy Conversion (OTEC), ocean thermal power plants, tidal energy conversion, Tidal and wave energy its scope and development, Scheme of development of tidal energy.

**Small hydro Power Plant:** Importance of small hydro power plants and their Elements, types of turbines for small hydro, estimation of primary and secondary power.

**Geothermal Energy**: Geothermal power plants, various types, hot springs and steam ejection.

**TEXT BOOKS**:

1. G.DRai,"Non-Conventional Energy Sources", New Edition, Khanna Publishers, 1988.
2. Jhon Twidelland Tony Weir,"Renewable Energy Sources" 3rd Edition, Routledge Publisher,2015.

**REFERENCES:**

1. D.P.Kothari, K.C.Singal, Rakesh Rajan ," Renewable Energy Sources and Emerging Technologies", New Edition, Prentice Hall India Learning, 2011.
2. VVNKishore, "Renewable Energy Engineering and Technology",New Edition, The Energy Resource Institute, Teri Press, 2010.
3. Godfrey Boyle, "Renewable Energy:Power for a Sustainable Future",3rd Edition, Oxford University Press, 2012.

**21ME4177: ADVANCED MATERIALS TECHNOLOGY**
**(PROFESSIONAL ELECTIVE-IV)**

**B.Tech.IV Year- I Sem.** **L T P C**
**3 0 0 3**

**Pre-Requisites**: Basic Metallurgy and Material science

**Course Objectives:**

1) To Understand applications of Ferrous Materials
2) To Understand applications of Non Ferrous and Composite Materials
3) To get awareness about FGM & SMA
4) To get awareness about Bio Materials
5) To Understand the Importance of Ceramics

**Course Outcomes:**

At the end of the course Students will be able to

1) Know the applications of Ferrous Materials
2) Select the suitable Non ferrous materials and Composite materials for different applications
3) Know the Importance of FGM & SMA
4) Understand the applications of Bio Materials
5) Know different applications of ceramic materials

**UNIT-I**

**Introduction to Ferrous materials:** Plain Carbon steels, Properties and applications of plain carbon steels, effect of alloying elements in plain carbon steels, Alloy steels, Tool steels, stain less steels, Low and High temperature resisting steels, High strength steels, Specifications of steels, Cast irons White grey nodular malleable Alloy Cast iron and SG Cast irons

**UNIT-II**

**Non Ferrous materials:** Copper and its alloys, Aluminum and its alloys, Magnesium and its alloys, Titanium and its alloys, bearing materials, Heat treatment of Nonferrous materials. Precipitation hardening of Aluminum alloys.

**Composite:** Polymer- Polymer, Metal- Metal, Ceramic – Ceramic, Ceramic – Polymer, Metal Ceramic, Metal- Polymer Composites. Dispersion reinforced, particle reinforced, laminated and fiber reinforced composites.

**UNIT-III**

**Functionally Gradient Materials (FGM):** Classification of FGMS, Preparations, Properties and applications of FGM system.

**Shape Memory Alloys (SMA):** Introduction, Shape Memory effect, Classification of Shape memory alloys, Composition, Properties and Application of SMA"s. Refractory materials and Coatings for high temperature applications.

**UNIT-IV**

**Bio Materials:** Classes and application of materials in medicine and Dentistry, Metallic Biomaterials, Cobalt and Titanium based Materials.

**UNIT-V**

**Ceramics:** Introduction to Ceramics and Polymers, Cermets, Classification and Fabrication Techniques, Bonding and Microstructure, Oxide Cermets, Carbide and Carbo nitride Cermets, Steel bonded Cermets. Properties and Applications.

**TEXTBOOKS:**

1. Biomaterials Science-An Introduction to Materials in Medicine/Buddy D .Rattner, A. S. Hoffman, F. J. Sckoen, and J.E.LEmons/Academic Press
2. Biomaterials:AnIntroduction/JoonB.ParkandRodericS.Lakes/PlenumPress

**REFERENCES:**

1. Handbook of Materials for MedicalDevices/J.R.Davis/ASM
2. Introduction to Nuclear Engineering/J.RLamarsh/Prentice Hall
3. Introduction to Physical Metallurgy / SYDNEY H AVNER/ 2nd Edition
4. Physical Metallurgy by Prof Vijendra Singh.

**21ME4178: ROBOTICS**
**(PROFESSIONAL ELECTIVE- IV)**

**B.Tech. IV Year- I Sem.** **L T P C**
**3 0 0 3**

**Course objectives:**

1) The goal of the course is to familiarize the students with the concepts and techniques
2) Robotic engineering and incorporate robotic technology in engineering systems.
3) Make the students acquainted with the theoretical aspects of Robotics
4) Make the students to understand the importance of robots in various fields of engineering.
5) Expose the students to various robots and their operational details.

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

1) Understand Robot, types and its classification.
2) Understand Robot actuators, feedback components, grippers.
3) Apply D-H Notations for Transformation kinematics.
4) Analyze forces in links and joints of a robot.
5) Study the applications of robots in different fields of Engineering.

**UNIT–I**

**Introduction**: Automation and Robotics, An overview of Robotics–present and future applications Classification by Coordinate system and control systems. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors. Mechanical Grippers – Magnetic – Vacuum Cup and other types of grippers- General Considerations on gripper selection and design

**UNIT– II**

Motion Analysis: Basic Rotation Matrices,Equivalent Axis and Angle,Euler Angles,Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation– problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulation.

**UNIT–III**

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange –Euler and Newton – Euler formations – Problems. Trajectory planning and avoidance of obstacles, ath planning, Slew motion, joint interpolated motion – straight line motion.

**UNIT IV**

**Robot actuators and Feedback components:**

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders –Velocity sensors, Tactile and Range sensors, and Force and Torque sensors.

**UNIT V**

Robot Application in Manufacturing: Material Transfer- Material handling, loading and unloading-Processing-spot and continuous arc welding &spray painting-Assembly and Inspection.

**TEXTBOOKS:**

1. Industrial Robotics/ Groover MP /McGrawHill
2. Introduction to Industrial Robotics/ Ramachandran Nagarajan/ Pearson

**REFERENCES:**

1. Robot Dynamics and Controls/ Spony and Vidyasagar /John Wiley.
2. Robot Analysis and control/Asada, Slotine/Wiley Inter-Science
3. Rajput R.K., Robotics and Industrial Automation, S.Chand and Company, 2008.
4. Craig J.J., Introduction to Robotics Mechanics and Control, Pearson Education, 2008

## 21ME4151: ADDITIVE MANUFACTURINGTECHNOLOGY LABORATORY

**B.Tech IV Year-I Sem.** **L T P C**
**0 0 3 1.5**

**Pre-Requisites**: Machining & Machine Tools Technology

**Course Objectives:**

1. To gain knowledge of fundamental concepts of Additive Manufacturing.
2. To understand the techniques of Additive Manufacturing for different industrial applications.
3. To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques.
4. To familiarize students with different processes in rapid prototyping systems.
5. To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

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

1. Develop STL file for CAD models with appropriate support structures and orientation.
2. Build complex engineering assemblies in plastic material with minimum build-time.
3. Evaluate the process parameters of AM machine to improve the quality of the parts produced.
4. Model and fabricate working models using AM processes.
5. Improve surface finish of fabricated components by post-processing techniques.

**List of Experiments:**

1. Introduction to Ultimaker CURA &Fractral Works Slicing software.
2. Developing a 3D CAD model using Advanced Mechanical Engineering software"s suchas Fusion 360 / NX-UG / Cre-O / CATIA / Solid Works.
3. Introduction to different types of 3D printing file formats.
4. Developing .STL file format using CAD model.
5. Developing a 3D CAD model G-code using CURA slicing software.
6. Manufacturing of a FDM based 3D prototype using a Delta Printer.
7. Manufacturing of a FDM based 3D prototype using a Julia Basic / Intermediate FractralWorks Printer.
8. Manufacturing of a FDM based 3D prototype using a Julia Extended Fractral Works Printer.
9. Generating .STL files from CAD models and working on STL file problems.
10. Creating a Topology Optimization based modified design using existing 3D CAD models by Generative Design option using advanced CAD software such as Fusion 360.

## 21ME4152: INSTRUMENTATION & CONTROL SYSTEMS LABORATORY

**B.Tech. IV Year-I Sem.**

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| 0 | 0 | 3 | 1.5 |

**Prerequisites: Theoretical exposure to Metrology & Instrumentation**

**COURSE OBJECTIVES:**

1) To acquire the knowledge of Engineering metrology and its practice this is having increasing importance in industry.
2) To specifically make the student to improve applications aspect in the measurements and control of process of manufacture.
3) To impart the practical knowledge on how to measure line standard and end standard measurements.
4) Understanding the basic characteristics of a typical instrument.
5) Identifying errors and their types that would occur in an instrument.

**COURSE OUTCOMES:**

At the end of the course, the student will be able to

1) Perform the linear and angular measurements using various instruments.
2) Measurement of gear, thread parameters and surface roughness.
3) Characterize and calibrate measuring devices.
4) Identify and analyze errors in measurement.
5) Analyze measured data using regression analysis.

**List of Experiments**

1. Calibration of Pressure Gauge.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge apparatus.
5. Study and calibration of a Rotameter for flow measurement.
6. Measurement and control of Pressure of a process using SCADA system.
7. Measurement and control of level in a tank using capacitive transducer with SCADA.
8. Measurement and control of temperature of a process using resistance temperature detector with SCADA.
9. Measurement and control of flow of a process using SCADA systems.

**21ME4181**: **MINI PROJECT**

**IV B. Tech. I Sem**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**21ME4271: AUTOMATION IN MANUFACTURING**
**(PROFESSIONAL ELECTIVE-V)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Course Objectives:**

1) The Aim of the course is to familiarize the students with fundamental concepts of Automation in manufacturing
2) To make the students understand the Technique of automation
3) To make the students understand the assembly lines in manufacturing
4) To understand Automated Material handling equipments and Automated Storage Systems.
5) To understand industrial control and automatic inspection techniques.

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

1) Understand the automation in manufacturing and automated flow lines
2) Differentiate AMS and Manufacturing support systems
3) Design and implement electro –pneumatic / Hydraulic solutions for automated systems
4) Understand material handling and storage systems
5) Understand Automated storage and retrieval systems.

**UNIT–I**

**Introduction** Types and strategies of automation, pneumatic and hydraulic components circuits, Automation in machine tools. Mechanical feeding and tool changing and machine tool control transfer the automaton.

**UNIT– II**

**Automated flow lines**: Methods or work part transport transfer Mechanical buffer storage control function, design and fabrication consideration.

**Analysis of Automated flow lines**: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

**UNIT–III**

**Assembly system and line balancing**: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

**Automated material handling**: Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems.

**UNIT-IV**

**Automated storage systems**, automated storage and retrieval systems, work in process storage, interfacing handling and storage with manufacturing.

**Adaptive control systems:** Introduction, adaptive control with optimization, Adaptive control with constraints, Applications of A.C in machining operations. Use of various parameters such as cutting force, Temperatures, vibration and acoustic emissions.

**UNIT–V**

**Business process Re-engineering**: Introduction to BPE logistics, ERP, Soft ware configuration of BPE, concurrent Engineering, Techniques of Rapid Prototyping.

**TEXTBOOKS:**

1. Automation Production systems and computer integrated manufacturing / M. P Groover / Pearson.
2. Industrial Automation / Vikalp Joshi Manoj Adhikari Raju Manoj Rajesh Singh Anita Gehlot. BPB Publications.

**REFERENCES:**

1. CAD/CAM/CIM/ Radhakrishnan /NewAge
2. AdvancedManufacturingTechnology/KVaraPrasadaRao/KannaPublications.
3. Principles of Automation and Advanced Manufacturing Systems / Dr. K C Jain.
4. Manufacturing Processes and Automation / R. S Parmar / Khanna Publishers.

**21ME4272: MECHANICAL VIBRATIONS**
**(PROFESSIONAL ELECTIVE-V)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Pre-Requisites:** Theory of Machines-I and Theory of Machines-II

**Course Objectives:**

1) To Learn the importance of vibration analysis in machine parts.
- To Calculate the Laplace transforms of linear vibratory system.
- To Analyze the vibratory responses of single and multi-degree of freedom systems to various excitations.
- To Draw the mode shapes of two degree of freedom system.
- To Calculate the critical speed of shafts subjected to without and with damping.

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

1) Identify the need and importance of vibration analysis in machine parts.
2) Analyze the mathematical model of a linear vibratory system to determine its response
3) Determine vibratory responses of single and multi-degree of freedom systems to various excitations.
4) Construct the mode shapes of free and forced vibrations of two degree of freedom systems.
5) Solve the critical speeds of shafts with and without damping.

**UNIT I**

**Single Degree of Freedom Systems-I:** Undamped and damped free vibrations, force vibration coulomb damping, response to extension, rotating unbalance and support extension, vibration isolation and transmissibility.

**UNIT II**

**Single Degree of Freedom Systems-II:** Response to non-periodic excitations – Unit impulse, unit step and unit ramp functions – Response to arbitrary excitations – The convolution integral, shock spectrum, system response by the Laplace Transformation method.

**UNIT III**

**Vibration Measuring Instruments:** Vibrometers, velocity meters and accelerometers.

**UNIT IV**

**Two Degree Freedom System**: Principal modes– Undamped and damped free and forced vibrations, undamped vibration absorbers.

**UNIT-V**

**Critical Speed of Shafts:** Critical speeds without and with damping, secondary critical speeds.

**TEXT BOOKS:**

1. Elements of Vibrations analysis, Meirovitch, McGraw Hill Education.
2. Mechanical Vibrations, G.K.Groover,Nem Chand and Brothers.
3. Mechanical Vibrations, V.P.Singh,Dhanpatrai& Co.

**REFERENCES:**

1. Mechanical Vibrations, SS Rao, Pearson Education Limited.
2. Mechanical Vibrations, RaoV.Dukkipati and J.Srinivas, Prentice Hall India Learning Private Limited.
3. Mechanical Vibrations, J B K Das, Sapna Publications.
4. Vibration problems in Engineering, S.P.Timoshenko, John Wiley & Sons.
5. Mechanical Vibrations, S Graham Kellyk, Schaum‟s Outlines, McGraw Hill Education.

**21ME4273: DESIGN OF EXPERIMENTS**
**(PROFESSIONAL ELECTIVE-V)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Pre-Requisites:** Statistics and Probability

**Course Objectives:**

1) To understand concepts and techniques used in the design and analysis of experiments.
2) To understand the different models of an experimental design
3) To Know statistical analysis based on linear models
4) To understand the appropriate graphical methods.
5) To understand the logic, application, and interpretation of analysis of variance(ANOVA) models

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

1) Demonstrate history, role, and principle and steps experimentation.
2) Apply concepts of Probability and statistics in design of experiments.
3) Learn various DOE techniques.
4) Develops experiment design based on Taguchi method.
5) Analyses the experimental data of various experiments.

**UNIT I**

**Review of Statistics** – Normal distribution, distribution of sample means, t- distribution, F distribution, confidence interval, hypothesis testing. Fundamentals of Experimental Design Introduction, Experimentation, need for statistically designed Experiments, ANOVA, Basic principles of Design, Terminology use in DOE, Steps in Experimentation, Choice of Sample size, Cause and Effect Analysis, Simple Linear regression model.

**UNIT II**

**Simple Factor Experiments:** Completely randomized design- the statistical model, typical data for single factor experiment, ANOVA Multi factor factorial Experiments- two factor, three factor experiments – statistical model and estimation of model parameters.

**UNIT III**

**Taguchi Methods:**– Quality Loss function, Quality definition, Quality loss function, Nominal-thebest, smaller -the better case, larger -the better case, development of orthogonal arrays, robust design- system design, parameter design, basis of taguchi methods, steps in experimentation.

**UNIT IV**

**Design of Experiments:** Using orthogonal arrays – assignment of factors and interactions, linear graphs, selection and application of orthogonal arrays, data analysis from taguchi experiments – variable data with main factors and interactions.

**UNIT V**

Robust Design – Introduction, factors affecting response, objective functions in robust design, advantages of robust design, simple parameter design, relation between S? N ratio and quality loss.

**TEXT BOOKS**:

1.K. Krishnaiah, P. Shahabuddin, "Applied Design of Experiments and Taguchi Methods" PHIPublisher,2018.

2. Douglas C. Montgomery, "Design and Analysis of Experiments"Wiley& Sons, 2014.

**REFERENCES:**

1. Ross P. J, "Taguchi Techniques for Quality Engineering" 7th Edition -McGraw-Hill Book Company, NY,2008.

2. George E. P. Box, J. Stuart Hunter, Williams G. Hunter, "Statistics for Experimenters" 2nd Edition, Wiley Publishers.

3. Douglas C. Montgomery, "Design and Analysis of Experiments" 8th Edition WILEY India. 4. Jonathan D. Cryer and Kung- SikChan"Design of Experiments Simplified" 2nd Edition Springer.

**21ME4274: WELDING TECHNOLOGY**
**(PROFESSIONAL ELECTIVE-V)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Course Objectives:**

1) To illustrate the basic principles, capabilities, limitations of various welding processes.
2) To distinguish between the fusion and solid state welding processes.
3) To describe the effects of different process parameters on the characteristics of weld metallurgy.
4) To classify the weld ability of plain carbon steels, stainless steel, cast iron, aluminum and its alloys.
5) To explain various welding defects and their remedial measures and non destructive testing for defect evaluation in weldments.

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

1) Know the characteristics, electrode selection, types of equipment and power sources for Arc welding.
2) Apply the working principle of fusion and solid state welding techniques to join the similar ordissimilar metals.
3) Examine the various precision welding processes such as PAW, LBW, EBW, USW, frictionstir welding and under-water welding.
4) Compile the automation in welding and robotic application.
5) Examine the various welding defects by using non destructive testing methods.

**UNIT-I**

Review of welding processes, joint design, Process descriptions of and parametric influences on fusion welding; arc welding- SMAW, stud arc welding, GMAW, GTAW and FCAW, solid state welding processes- pressure welding, friction welding, diffusion welding; resistance welding processes.

**UNIT-II**

Arc welding- different types of equipment, power sources, arc characteristics, electrode selection, Critical and precision welding processes like: PAW, LBW, EBW, USW, friction stir welding, under-water welding. Welding of plastics, ceramics and composites.

**UNIT-III**

Welding metallurgy, HAZ, effects of different process parameters on the characteristics of weldment. Welding fixtures,

**UNIT-IV**

Welding automation and robotic application, Weldability of plain carbon steels, stainless steel, cast iron, aluminum and its alloys.

**UNIT-V**

Welding defects- types, causes, inspection and remedial measures; testing of welded joints by visual inspection, dye-penetration (DP) test, ultrasonics and radiography. Safe Practices in Welding.

**TEXT BOOKS:**

1. O.P. Khanna, A Text Book of Welding Technology, Dhanpat Rai & Sons.
2. R.S. Parmar, Welding Engineering and Technology, Khanna Publishers.

**REFERENCES**

1. M. Bhattacharyya, Weldment Design, The Association of Engineers, India Publication, Kolkata.
2. J.C. Lippold and D.J. Kotecki, Welding Metallurgy and Weldability of Stainless Steels, Wiley-India (P) Ltd., New Delhi.

**21ME4275: MACHINE TOOL DESIGN**
**(PROFESSIONAL ELECTIVE-VI)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Pre-Requisites:** Design of Machine Members, Machine Tools and Metrology.

**Course Objectives:**

1) To Implement the tool design process when designing tooling for the manufacturing of product.
2) To Evaluate and select appropriate materials for tooling applications.
3) To Design, develop, and evaluate cutting tools and work holders for a manufactured product.
4) To Design, develop, and evaluate tooling for various joining processes.
5) To Design the various Guideways systems and test the machine tools at dynamic state

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

1) Understand the basic motions involved in a machine tool.
2) Design machine tool structures.
3) Design and analyze systems for specified speeds and feeds.
4) Select subsystems for achieving high accuracy in machining.
5) Understand control strategies for machine tool operations.

**UNIT I**

**Introduction to Machine Tool Drives and Mechanisms:** Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission.

**UNIT II**

**Regulation of Speeds and Feeds:** Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed GearBoxes, Feed Drives, Feed Box Design.

**UNIT III**

**Design of Machine Tool Structures:** Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages.

**UNIT IV**

**Design of Guideways, Power Screws and Spindles:** Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slideways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws Design of Spindles and Spindle Supports: Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings.

**UNIT V**

**Dynamics of Machine Tools:** Machine Tool Elastic System, Static and Dynamic Stiffness Acceptance Tests.

**TEXT BOOKS**:

1. N.K. Mehta, "Machine Tool Design and Numerical Control" Mc GrawHill.
2. G.C. Sen and A. Bhattacharyya, "Principles of Machine Tools Design" New Central Book Agency.

**REFERENCES:**

1. D. K Pal, S. K. Basu, "Design of Machine Tools" Oxford
2. N. S. Acherkhan"Machine Tool Design, Vol. I, II, III and IV" MIR.
3. N. K. Mehta, "Machine Tool Design" Tata McGraw-Hill Education.
4. M Yoshimura, "Machine Tool Design" Springer
5. K. CHITALE and R.C. Gupta, "Product Design and Manufacturing" 6th Edition PHI.

**21ME4276: GAS TURBINES FOR POWER AND PROPULSION**
**(PROFESSIONAL ELECTIVE-VI)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Pre-Requisites:** Thermal Engineering

**Course Objectives:**

1) To Understand basic concepts of Turbo machinery
2) To understand about different Cycles
3) To Get awareness about gas turbine cycles
4) To understand about jet propulsion
5) To understand about different types of compressors

**Course Outcomes:**

At the end of the course, the students will develop ability to

1) Use dimensional Analysis to compare homologous machines.
2) Select the type of gas turbine cycle used for a particular application.
3) Contrast the efficiency of ideal and practical gas turbine cycles.
4) Discuss the types of jet propulsion, efficiency & Thrust factor.
5) Understand the applications of different types of compressors

**UNIT-I**

Review of Basics: Definition of a turbo machine, parts of turbo machine, Comparison with positive displacement machine, Classification, Applications of first and second law of thermodynamics to turbo machines, efficiencies, dimensional analysis dimensionless numbers related to turbo machines and their physical significance. Energy Equation

**UNIT-II**

Ideal Gas Turbine Cycles: Analysis of Ideal Gas Turbine Cycles, Simple Cycle, Regeneration Cycle, Reheat Cycle, Inter cooling Cycle.

**UNIT-III**

Practical Gas Turbine Cycles: Analysis of Practical Gas Turbine Cycles, Methods of accounting for component losses, Efficiencies, change in the composition of the working fluid.

**UNIT-IV**

Propulsion Cycles: Jet Propulsion Cycles and their Analysis for turbojet, turboprop and turbofan Engines-efficiency and specific thrust Factors Affecting Flight Performance & Methods of Thrust Augmentation.

**UNIT V**

Centrifugal Compressors: Centrifugal Compressors- Principle of Operation, T-s diagram, Energy equation, velocity triangles, types of blades. Analysis of Flow, Performance Characteristics.
Axial Flow Compressors: Axial Flow Compressors – Construction, Principle of Operation, T-s diagram, Energy equation, velocity triangles. Analysis of Flow. Work done factor, Stage efficiency, Degree of reaction, Performance characteristics.

**TEXT BOOKS:**

1. V.Kadambi and Manohar Prasad, An introduction to energy conversion - Volume III-Turbo machinery, Wiley Basten Ltd. (1977).
2. D.G.Shepherd, Principles of Turbo Machinery, The Macmillan Company (1964). ISBN81-7319-563-3

**REFERENCES:**

1. S.M.Yahya Turbines, Compressors & fans, TMH 2 nd edition (2002). ISBN 10:0074519913 ISBN-13:978007451219912
2. H.Cohen, GFC Rogers , & HIH Saravanamuttoo, Gas turbine theory, Thomson press India Ltd.,4 th Edition (1998). ISBN: 81-297-0486-2
3. G Gopalakrishna& D Prithviraj, A treatise on Turbo machines, Scitech Publications Pvt. Ltd, 2002

**21ME4277: NON DESTRUCTIVE TESTING**
**(PROFESSIONAL ELECTIVE-VI)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Course Objectives:**
1. Identify the basic methods of testing.
2. Understand the properties of materials suitable for NDT test.
3. Understand the concept of non destructive testing.
4. Describe the various types of NDT tests carried out on components.
5. Familiarize with characteristics of ultrasonic test, transducers, rejection and effectiveness.

**Course Outcomes:** At the end of the course Students will be able to
1. Identify the requirements of testing criteria as per material composition.
2. Classify the various types of non destructive test used to determine the surface Cracks.
3. Explain the theory and requirement of non destructive testing methods used
4. Distinguish between the various NDT test as Ultrasonic and Eddy current methods.
5. Explain the types of radiations used in no destructive testing.

**UNIT - I**
**Overview of NDT -** NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, various physical characteristics of materials and their applications in NDT, Visual inspection.

**UNIT - II**
**Surface NDE Methods:** Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

**UNIT - III**
**Thermography and Eddy Current Testing** - Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing- Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

**UNIT - IV**
**Ultrasonic Testing and Acoustic Emission -** Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique IV Principle, AE parameters, Applications

**UNIT - V**

**Radiography** - Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

**TEXT BOOKS**:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu, "Practical Non-Destructive Testing¨, New Edition,Narosa Publishing House, 2009.
2. Ravi Prakash, Non-Destructive Testing Techniques¨, 1st Edition, New Age International Publishers, 2010

**REFERENCE BOOKS:**

1. ASM Metals Handbook, ¨Non-Destructive Evaluation and Quality Control¨, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", 2nd Edition ,Wiley ,New Jersey, 2005
3. Charles, J. Hellier," Handbook of Non-destructive evaluation", New Edition, McGraw Hill, NewYork 2001.

**21ME4278: PRODUCTION PLANNING AND CONTROL**
**(PROFESSIONAL ELECTIVE-VI)**

**B.Tech. IV Year -II Sem** **L T P C**
**3 0 0 3**

**Pre Requisites -NIL**

**Course Objectives:**

1. Explain Production Planning & Control with reference to an Industry and Elaborate need of Forecasting.
2. Explain about Inventory and Inventory managing techniques.
3. Examine the factors affecting routing procedure and steps involved in Material Requirement Planning.
4. Classify scheduling techniques and its implementation with different industries.
5. Summarize Dispatching, following procedure.

**Course Outcomes:** At the end of the course, the students will develop ability to

1. Execute required Forecasting method for different Forecasting problems.
2. Apply suitable Analysis to be applied to maintain Economical inventory.
3. Develop a route sheet for given product through line balancing problems.
4. Evaluate Shortest processing time from the scheduling problems.
5. Apply the knowledge of materials Dispatching, follow-up.

**UNIT – I**

**Introduction:** Definitions – Objectives of Production Planning and Control – Functions of production planning and control – Elements of production control - Types of production - Organization of production planning and control, Internal organizations department. **Forecasting**: Definition- importance of forecasting - factors affecting the forecast- types of forecasting and their uses-demand patterns - general principles of forecasting techniques quantitative techniques- qualitative techniques- measures of forecasting errors.

**UNIT – II**

**Inventory Management:** Functions of inventories – relevant inventory costs – ABC analysis – VED analysis –Basic EOQ model- Inventory control systems –continuous review systems and periodic review systems, MRP, ERP, JIT Systems-basic treatment only.

**Aggregate planning:** Definition – aggregate planning strategies – aggregate planning methods – transportation model.

**UNIT – III**

**Line Balancing:** Terminology, Methods of Line Balancing, RPW method-Largest Candidate ulemethod.

**Routing** – Definition – Routing procedure – Factors affecting routing procedure, Route Sheet.

**UNIT – IV**

**Scheduling:** Definition – Scheduling Policies – types of scheduling methods – difference with loading – flow shop scheduling **–** job shop scheduling, line of balance(LOB)-objectives-steps involved.

**UNIT – V**

**Dispatching:** Definition – activities of dispatcher – dispatching procedures – various forms used in dispatching.

**Follow up**: definition – types of follow up – expediting – definition – expediting procedures-Applications of computers in planning and control.

**TEXT BOOKS:**

1. Samuel Eilon, "Elements of Production Planning and Control", ISBN-13: 9788185027098.
2. R.K.Jain, "Production Planning and Control", Khanna publishers.

**REFERENCES:**

1. Ravi Shankar, "Industrial Engineering and management", Galgotia Publishers, 2nd Edition, ISBN Number: 978-8175156050.
2. Panner Selvam, "Production Operation Management", PHI Publishers, 2nd Edition, ISBN, 8120327675, 9788120327672.
3. Moore, "Production Control", ISBN 13: 9780070429215.
4. Joseph S. Martinich, "Production and Operations Management", John Willey & Sons, 1st Edition.

## 21CE4281: MAJOR PROJECT

**B.Tech IV Year II Semester**

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