



CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instruction as per R20 Curriculum

B.E. (MECHANICAL ENGINEERING)

Open Elective courses offered by MED

S.No	Semester	Open elective courses
1.	SEMESTER – V to SEMESTER – VIII	20ME O01 : Mechanism and Kinematics of Robots 20ME O02 : Human Values and Professional Ethics 20ME O03 : Research Methodologies 20ME O04 : Principles of Entrepreneurship 20ME O05 : Human Rights and Legislative Procedure 20ME O06 : Nano Materials and Technology 20ME O07 : Intellectual Property Rights 20ME O08 : Mechatronics 20ME O09 : Organizational Behaviour 20ME O10 : Introduction to Operations Research 20ME O11 : Modern Manufacturing Processes 20ME O12 : 3D Printing 20ME O13 : Industrial and Financial Management 20MEO14 : Principles of Management 20ME O15 : Principles of Industry 4.0 20 MEO16: Design Thinking

With Effect from the Academic Year 2023–24

20ME 001

MECHANISM AND KINEMATICS OF ROBOTS
(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Principle of working of a robot, types and specifications, configuration, work envelopes and motion controls and applications.
2. Transformations, kinematics and dynamics of robots.
3. Singularities, Jacobian and trajectory planning of a robot to prepare the robot for various tasks
4. Design of end effectors, drives, working of sensors and controllers for finding position and orientation.
5. Robot vision for image acquisition and processing and plan for various tasks and various Languages and Programming methods of robot.

Outcomes: At the end of the course, the students are able to

1. Describe the basic components, specifications and applications of the Robots.
2. Understand transformations, direct and inverse kinematics of robots.
3. Calculate forces in links and joints of a robot and find the singularities, Jacobian and trajectory planning of a robot for various tasks.
4. Classify drives, sensors and grippers for various applications.
5. Program a robot to predict motions for a given task with machine vision and sensors.

UNIT- I

Introduction to robotics: History and evolution of robots, basic configuration, degree of freedom, work envelope, motion control methods, various applications in industry, material handling, loading & unloading, processing, welding & painting, assembly, and inspection, requirements and specifications of robots.

UNIT- II

Rigid motions and homogeneous transformations: Rotation matrix, homogeneous transformation matrix, Denavit- Hartenberg convention, Euler angles, RPY representation, direct and inverse kinematics for industrial robots for position and orientation.

UNIT- III

Velocity kinematics – the manipulator Jacobian: joint, end effect or velocity, direct and inverse velocity analysis. **Trajectory planning:** Interpolation, cubic polynomial, linear segments with parabolic blending, static force and moment transformation, solvability, stiffness, singularities.

UNIT- IV

Robot dynamics: Lagrangian Formulation for link inertia tensor and manipulator inertia tensor, Newton- Euler formulation for RR & RP manipulators.

Control: Individual, joint and computed torque.

UNIT -V

End effectors: Position and velocity measurement. **Sensors:** Proximity and range, tactile, force and torque,

Drives for Robots: Electrical, Hydraulic and Pneumatic.

Robot vision: Introduction to technique, image acquisition and processing, introduction to robot programming languages

Text Books:

1. Spong and Vidyasagar, Robot Dynamics and Control, John Wile and Sons, 1990.
2. R.K. Mittal, I.J. Nagrath, Robotics and control, Tata Mcgraw-Hill Publishing Company Ltd., 2003.
3. Groover, Industrial Robotics, Mcgraw-Hill Publishing Company Ltd. 2003.

Suggested Reading:

1. Asada and Slotine, Robot analysis and Intelligence, Wiley Interscience, 1986.
2. K.S. Fu Gonzalez RC., IEEc.S.G., Robotics, Control Sensing Vision and Intelligence, McGraw Hill, Int.ed, 1987.

With Effect from the Academic Year 2023–24

20ME 002

HUMAN VALUES AND PROFESSIONAL ETHICS (Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Understand the significance of values in life.
2. Understand the need for value adoption and prepare them meet the challenges.
3. Develop the potential to adopt values, develop a good character and personality and lead a happy life.
4. Practice the values in life and contribute for the society around them and for the development of the institutions/organization.
5. Understand the professional ethics and their applications to engineering profession.

Outcomes: At the end of the course, the students are able to

1. State basic values and the need for value education.
2. Analyze the situation and prioritize values for making right decisions in their personal as well as professional life.
3. Understand the role of a human being in ensuring harmony in society and nature.
4. Demonstrate the knowledge of ethics at their work place and apply different theoretical approaches to solve ethical dilemmas.
5. Apply risk and safety measures in the engineering practice.

UNIT-I

Concepts and classification of values –need and challenges for value adoption: Definition of values , concept of values, classification of values, hierarchy of values, types of values, espoused and applied values, value judgment based on culture , value judgment based on tradition , interdependence of values, need for value education ,findings of commissions and committees, corruption and illegal practices , science and technology without values, exploitation of nature, increasing use of violence and intoxicants , lack of education in values , implications of education in values , vision for a better India, challenges for value adoption , cultural, social, religious, intellectual and personal challenges.

UNIT-II

Personality development and values in life: Enlightened self-interest, accountability and responsibility , desires and weaknesses , character development, good relationships, self-restraint, spirituality and purity, the quest for character , tests of character , the key to good character ,values in life, building an ethical policy, integrating values in everyday life, archaic social values , parenting practices, critical thinking, analyzing and prioritizing values, practicing yoga and meditation.

UNIT-III

Practicing values for the development of society: Resentment management and self- analysis, positive thinking and emotional maturity, the importance of women , children and taking care of them, helping the poor and needy, fighting against addictions and atrocities, environmental

awareness, working for the sustainable development of the society, values in education system, present scenario, engineering education, current trends, need for quality improvement, adoption of value education, principles of integrity, institutional development.

UNIT-IV

Basic concepts of professional ethics: Ethics, morals and human life, types of ethics, personal ethics, professional ethics, ethical dilemmas, Indian and global thoughts on ethics, profession, professional and professionalism, ethical role of a professional basic ethical principles, some basic ethical theories, use of ethical theories - science, religion ethics, genders and ethics, media and ethics, computer ethics, case studies on professional ethics, exemplary life sketches of prominent Indian personalities.

UNIT- V

Ethics in engineering profession: Engineering profession, technology and society, engineering as social experimentation, engineering ethics, ethical obligations of engineering professionals, role of engineers, engineers as managers, professional responsibilities of engineers, engineers responsibility for safety, a few case studies on risk management, conflicts of interest, occupational crimes, plagiarism, self-plagiarism, ethics audit, consideration for ethics audit, ethics standards and bench marking.

Text Books:

1. Subramanian R., Professional Ethics, Oxford University Press, 2017.
2. Dinesh Babu S., Professional Ethics and Human Values, Laxmi Publications, 2016.
3. Nagarajan R.S., A Text Book on Human Values and Professional Ethics, New Age Publications, 2007.

Suggested Reading:

1. Santosh Ajmera and Nanda Kishore Reddy, Ethics, Integrity and Aptitude, McGraw Hill Education Private Limited, 2014.
2. Govinda Rajan M., Natarajan S., Senthil Kumar V.S., Professional Ethics and Human Values, Prentice Hall India Private Limited, 2013.

With Effect from the Academic Year 2023–24

20ME O03

RESEARCH METHODOLOGIES
(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. To make the students to formulate the research problem.
2. To identify various sources for literature review and data collection.
3. To prepare the research design.
4. To equip the students with good methods to analyze the collected data.
5. To explain how to interpret the results and report writing.

Outcomes: At the end of the course, the students are able to

1. Define research problem.
2. Review and assess the quality of literature from various sources.
3. Understand and develop various sresearch designs.
4. Analyze problem by statistical techniques: ANOVA,F-test,Chi-square.
5. Improve the style and format of writing a report for technical paper/Journal report.

UNIT – I

Research methodology: Objectives and motivation of research, types of research-descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical, research approaches, significance of research, research methods vs. methodology, research process, criteria of good research, problems encountered by researchers in India, technique involved in defining a problem.

UNIT–II

Literature survey: Importance of literature survey, sources of information-primary, secondary, tertiary, assessment of quality of journals and articles, information through internet.

UNIT – III

Research design: Meaning of research design, need of research design, feature of a good design important concepts related to research design, different research designs, basic principles of experimental design, steps insample design.

UNIT – IV

Data collection: Collection of primary data, Secondary data, measures of central tendency-mean, mode, median, measures of dispersion- range, mean deviation, standard deviation, measures of asymmetry (skewness), important parametric tests -z, t, F, Chi-Square, ANOVA significance.

UNIT – V

Research report formulation and presentation: Synopsis, dissertation, technical paper and journal paper, writing research grant proposal, making presentation with the use of visual aids, writing a proposal for research grant.

Text Books:

1. C.R Kothari, Research Methodology Methods & Technique, New Age International Publishers, 2004.
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011.
3. Vijay Upagade and AravindShende, Research Methodology, S. Chand &Company Ltd., New Delhi, 2009.

Suggested Reading:

1. G. NageswaraRao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.
2. Naval Bajjai, Business Research Methods, Pearson Education,2011.

With Effect from the Academic Year 2023–24

20ME O04

PRINCIPLES OF ENTREPRENEURSHIP
(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Concept and procedure of idea generation.
2. The nature of industry and related opportunities and challenges.
3. Elements of business plan and its procedure.
4. Project management and its techniques.
5. Behavioural issues and Time management.

Outcomes: At the end of the course, the students are able to

1. Understand the concept and essence of entrepreneurship.
2. Identify business opportunities and nature of enterprise.
3. Analyze the feasibility of new business plan.
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects.
5. Use behavioral, leadership and time management aspects in entrepreneurial journey

UNIT-I

Entrepreneurship: Definition, functions of entrepreneurship, qualities of entrepreneurs, identification and characteristics of entrepreneurs, entrepreneur vs. intrapreneur, first generation entrepreneurs, women entrepreneurs, conception and evaluation of ideas and their sources.

UNIT-II

Indian industrial environment: Competence, opportunities and challenges, entrepreneurship and economic growth, small scale industry in India, objectives, linkage among small, medium and heavy industries, types of enterprises, corporate social responsibility.

UNIT-III

Business plan: Introduction, elements of business plan and its salient features, business model canvas, technical analysis, profitability and financial analysis, marketing analysis, feasibility studies, executive summary, selection of technology and collaborative interactions.

UNIT-IV

Project management: During construction phase, project organization, project planning and control using CPM, PERT techniques, human aspects of project management, assessment of tax burden.

UNIT-V

Behavioral aspects of entrepreneurs: Personality, determinants, attributes and models, leadership concepts and models, values and attitudes, motivation aspects, time management: approaches of time management, their strengths and weaknesses. time management matrix and the urgency addiction .

Text Books:

1. Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 1997.
2. Prasanna Chandra, Project-Planning, Analysis, Selection, Implementation and Review, Tata Mcgraw-Hill Publishing Company Ltd, 1995.
3. S.S. Khanka, Entrepreneurial Development, S. Chand & Co. Pvt. Ltd., New Delhi, 2015.

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, Entrepreneurship, 5th edition, Tata Mc Graw Hill Publishing Company Ltd., 2005.
2. Stephen R. Covey and A. Roger Merrill, First Things First, Simon and Schuster Publication, 1994.

With Effect from the Academic Year 2023–24

20ME O05

HUMAN RIGHTS AND LEGISLATIVE PROCEDURE
(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Understand the value of human rights.
2. Understand the Lawful rights available to him and others.
3. Create understanding the rights of under privileged and respect them.
4. Understand role of an individual in the Civil Society.
5. Understand the safety aspects while using technology and to understand the role of NGO in protecting human rights and environment.

Outcomes: At the end of the course, the students are able to

1. Recall the human rights in the global and national context.
2. Understand the overall view on working of Indian constitution.
3. Analyze the societal problems in the context of human rights.
4. Evaluate implementation of right to development and right to information.
5. Application of human rights for human safety and clean environment.

UNIT-I

Meaning and concept of human rights: Notion and classification of rights, moral and legal rights, three generations of rights (civil, and political rights, economic social and cultural rights, collective/solidarity rights), Indian bill of rights and sarvodaya, preamble of Indian constitution, fundamental rights-directive principles- fundamental duties .

UNIT-II

Human rights enforcement mechanism: Human Rights Act, 1993, judicial organs-Supreme Court (Article 32) and high court (Article 226), human rights commission, National and State commission of Women/Children/Minority/SC/ST.

UNIT-III

A right to development: Socio-economic and cultural effects of globalization, right to education, transparency in governance and right to information, consumer protection act.

UNIT-IV

Environment rights such as right to clean environment and public safety: Issues of industrial pollution, prevention, and rehabilitation, safety aspects of new technologies such as chemical and nuclear technologies, issues of waste disposal, protection of environment.

UNIT-V

Role of advocacy groups: Professional bodies, press, media role of lawyers legal Aid., educational institutions, corporate Sector and N.G.Os.

Text Books:

1. Kapoor, S.K., Human rights under International Law and Indian Law, Prentice Hall of India, New Delhi, 2002
2. P.M. Katare and B.C. Barik, Development, Deprivation and Human Rights, Violation, New Delhi, Rawat, 2002.
3. S.N. Chaudhary, -Human Rights and Poverty in India: Theoretical Issues, Delhi: Concepts, 2005.

Suggested Readings:

1. Frankena, W.K., Ethics, Prentice Hall of India, New Delhi, 1990.
2. K.P. Saksena, Human Rights and the Constitution: Vision and the Reality, New Delhi: Gyan Publications, 2003.

With Effect from the Academic Year 2023–24

20ME O06

NANO MATERIALS AND TECHNOLOGY
(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Nanotechnology approach and challenges.
2. Materials and characterization procedures.
3. Zero and one dimensional nanostructures.
4. Various fabrication techniques.
5. Special nano materials and nano biomaterials.

Outcomes: At the end of the course, the students are able to

1. Understand the basic concepts, developments and challenges in nanotechnology.
2. Describe the methods of evaluating magnetic and electronic properties, microstructure by spm and atomicforce microscopy.
3. Apply heterogeneous methods and characterization techniques of zero & one dimensional nanostructures.
4. Evaluate various nano material fabrication techniques.
5. Analyze nano materials and nano bio materials for obtaining solutions to societal problems.

UNIT - I

Introduction: Nanoscale, properties at nanoscale, advantages and disadvantages, importance of nanotechnology, bottom-up and top-down approaches, challenges in nanotechnology.

UNIT - II

Materials of Nanotechnology: Introduction, Si-based materials, Ge-based materials, ferroelectric materials, polymer materials, GaAs & InP (III-V) group materials, nano tribology and materials, characterization using scanning Probe microscope, AFM.

UNIT - III

Nano structures: Zero dimensional nanostructure, synthesis procedure by heterogeneous method, characterization techniques, properties and applications of nano particles

One dimensional nanostructures: Synthesis procedure, characterization procedure and principles involved, properties and applications of nanowires .

UNIT - IV

Nano fabrication: Introduction, basic fabrication techniques by lithography and doping, MEMS fabrication techniques, nano fabrication techniques by E-beam, nano-imprint fabrication, epitaxy and strain engineering.

UNIT - V

Special nano materials: Introduction, synthesis procedure by metal-polymer, characterization procedures, applications.

Nano biomaterials: Introduction, biocompatibility, anti-bacterial activity, applications.

Text Books:

1. Dieter Vollath, Nanomaterials: An introduction to Synthesis, properties and applications, Wiley, 2013.
2. Guozhong Cao, Nanostructures and Nano Materials, Synthesis properties and applications, Imperial College Press, 2004.
3. Carl C Koch, Nano materials Synthesis, Properties and applications, Jaico Publishing House, 2008.

Suggested Reading:

1. WilliaTllsey Atkinson, Nano Technology, Jaico Publishing House, 2009.
2. George W. Hanson, Fundamentals of Nano electronics, Pearson Education, 2009.

With Effect from the Academic Year 2023–24

20ME O07

INTELLECTUAL PROPERTY RIGHTS

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Fundamental aspects of IP.
2. Salient features of IPR acts.
3. The methods of registrations of Intellectual property.
4. Awareness for innovation and its importance of protection.
5. The changes in IPR culture and techno-business aspects of IPR.

Outcomes: At the end of the course, the students are able to

1. Understand the evolution of IP, working of organization's at global level to protect and promote IP.
2. Familiarize with the patent filing process at national and international level.
3. Draw the logical conclusion of research, innovation and patent filing.
4. Compare different kinds of IP and their patenting system.
5. Understand the techno-legal-business angle of IP, infringement and enforcement mechanisms for protection.

UNIT-I

Introduction: Definition of intellectual property, the need for intellectual property rights (IPR), kinds of intellectual property rights, IPR in India – genesis and development, IPR abroad, importance of WTO, TRIPS agreement, patent cooperation treaty, Berne and universal copyright conventions.

UNIT-II

Patents: Definition of patent, commercial significance, term of patent, patentable subject-matter, rights and obligations of patentee, searching of existing patents, drafting of patent, specification of patent, filing of a patent, the different layers of the patent system (national, regional and international options), compulsory licensing and licenses of rights, revocation of patents, differences between utility model and patent.

UNIT-III

Industrial designs: Definition of designs, registration of design, rights and duties of proprietor of design, piracy of registered design.

Trademarks: Meaning of trademarks, purpose of protecting trademarks, registration of trademarks, passing off, assignment and licensing of trademarks, infringement of trademarks.

Geographical indications: Definition, differences between GI and trademarks.

UNIT-IV

Copy right: Nature and scope of copy right, term of copyright, subject matter of copyright, rights conferred by copyright ,publication, broad casting, telecasting, computer program, database protection, assignment and transmission of copyright, infringement of copy right trade secrets and know-how agreement.

UNIT-V

Enforcement of intellectual property rights: Infringement of intellectual property rights, enforcement measures, emerging issues in intellectual property protection, case studies of patents and IP Protection.

Unfair competition: What is unfair competition, relationship between unfair competition and intellectual property laws.

Text Books:

1. Ajit Parulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd., 2006.
2. B.L.Wadehra, Law relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications, Universal law Publishing Pvt Ltd., India, 2000.
3. P.Narayanan, Law of Copyright and Industrial Designs; Eastern law House, New Delhi, 2010.

Suggested readings:

1. Cronish W.R, Intellectual Property Patents, Copyright, Trade Marks and Allied rights, Sweet & Maxwell, 1993.
2. P.Narayanan, Intellectual Property Law, Eastern Law Edn., 1997.

20ME O08**MECHATRONICS**

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. To identify, formulate and solve current engineering problems.
2. To design a system, component, or process to meet desired needs within realistic constraints.
3. To use the techniques, skills, and modern engineering tools necessary for engineering practice.
4. The use of drive mechanisms and fluid power systems and related electronic devices.
5. To demonstrate the design of modern CNC machines and modern mechatronics systems.

Outcomes: At the end of the course, the students are able to

1. Understand the concept of mechatronics and analyze electrical and mechanical systems and their interconnection for a given application.
2. Apply mechanical, electronics, control, and computer engineering in the design of mechatronics systems to specific applications.
3. Analyze the design, interfacing, and actuation of a mechatronics system to given specifications.
4. Recommend the use of industrial electronic devices, fluid power systems in various mechatronics applications.
5. Develop the design of modern CNC machines and modern mechatronics systems.

UNIT-I

Introduction to mechatronics systems, measurement systems and control systems: Need of interface of electrical & electronic devices with mechanical elements, the concept of mechatronics, flow chart of mechatronics system, elements of mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development .

UNIT-II

Actuation systems: Pneumatic and hydraulic systems, valves, pumps and accessories, hydraulic circuits, mechanical servo control circuits, electro-hydraulic servo control and hydro-pneumatic circuit examples.

Mechanical actuation systems: Cams-gear trains, ratchet and pawl etc. **Electrical actuation systems:** mechanical switches, solenoids, DC motors, AC motors, stepper motors, servo motors.

UNIT-III

Sensors and transducers: Performance terminology, sensors for displacement, position and proximity, velocity, motion, force, fluid pressure, liquid flow, liquid level, temperature, (thermistor, thermo couple), light sensors, selection of sensors.

UNIT-IV

8085 Microprocessor: Introduction, architecture, configuration- programming using 8085 instructions , interfacing input and output devices, D/A connectors and A/D connectors, applications.

Programmable logic controllers: Introduction, basic structure, input/output processing, programming, mnemonics, timers, internal relays and counters, data handling, analog input/output, selection of a PLC.

UNIT-V

Design of modern mechatronics systems: Stages in designing of mechatronics, traditional and mechatronic design, possible design solutions, case studies of mechatronics systems, pick and place robot, automatic car park systems, automatic washing machine, engine management systems.

Text Books:

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education.
2. HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
3. Michaels Histan& David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw- Hill, International Edition, 2011.

Suggested Reading:

1. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning, 2010.
2. S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, New Delhi, 2006

20ME O09

ORGANIZATIONAL BEHAVIOUR

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Define basic organizational behavior principles and analyze how these influence behavior in the work place.
2. Analyze the influence of perceptions and personality on individual human behavior in the work place.
3. Discuss the theories of Motivation and Leadership.
4. Provide knowledge on different organizational structures; and concepts of culture, climate and organizational development and make the students familiarize with individual behavior.
5. Describe the interpersonal and their intrapersonal reactions within the context of the group and alsodemonstrate effective communication and decision making skills in small group settings.

Outcomes: At the end of the course, the students are able to

1. Understand Organizational Behavioral principles and practices.
2. Compare various organizational designs and cultures enabling organizational development.
3. Apply motivational theories and leadership styles in resolving employee's problems and decision making processes.
4. Understand the group dynamics, communication network, skills needed to resolve organizational conflicts.
5. Analyze the behavior, perception and personality of individuals and groups in organizations in terms of the key factors that influence organizational behavior.

UNIT – I

Introduction: Organizational behaviour, nature and levels of organizational behavior, individuals in organization, individual differences , personality and ability, the big 5 model of personality , organizationally relevant personality traits, the nature of perception , characteristics of the perceiver, target and situation , perceptual problems.

UNIT – II

Organization structure: Organizational designs and structures, traditional and contemporary organizational designs, organizational culture and ethical behavior , factors shaping organizational culture, creating an ethical culture, concepts, organizational climate, organization conflict, and organization development.

UNIT – III

Motivation and leadership: Motivation, early and contemporary theories of motivation, leadership, early and contemporary approaches to leadership.

UNIT – IV

Group dynamics: Groups and group development, turning groups into effective teams, managing change , process, types and challenges, communicating effectively in organizations, communication process, barriers to communication, overcoming barriers to communication, persuasive communication, communication in crisis situations.

UNIT – V

Power, Politics, Conflict and Negotiations: Power, politics, conflict and negotiations, sources of individual, functional and divisional power, organizational politics conflict, causes and consequences, Pondy's model of organizational conflict, conflict resolution strategies.

Text Books:

1. Jennifer George and Gareth Jones, Understanding and Managing Organizational Behavior, Pearson Education Inc., 2012.
2. Jon L Pierce and Donald G. Gardner, Management and Organizational behavior, Cengage Learning India (P) Limited, 2001.
3. Richard Pettinger, Organizational Behaviour, Routledge, 2010.

Suggested Reading:

1. Stephen P. Robbins, Jennifer George and Gareth Jones, Management and Organizational Behaviour, Pearson Education Inc., 2009.
2. John Schermerhorn, Jr., James G. Hunt and Richard N. Osborn, Organizational Behaviour, 10th edition, Wiley India Edition, 2009.

20MEO10

INTRODUCTION TO OPERATIONS RESEARCH
(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Students will come to know the formulation of LPP models.
2. Students will understand the Algorithms of Graphical and Simplex Methods,
3. Students will understand the Transportation and Assignment techniques.
4. Students will come to know the procedure of Project Management along with CPM and PERT techniques.
5. Students will understand the concepts of sequencing.

Outcomes: At the end of the course, the students are able to

1. Understand the concepts of linear programming problem.
2. Solve the given transportation problem.
3. Develop optimum pair of operations and resources by using assignment technique.
4. Analyze project management techniques like CPM and PERT to plan and execute projects successfully.
5. Apply sequencing concepts for industry applications.

UNIT-I**Introduction:** Definition and scope of operations research**Linear programming:** Introduction, formulation of linear programming problems, graphical method of solving LP problem, simplex method, degeneracy in simplex method**UNIT-II****Transportation models:** Finding an initial feasible solution - north west corner method, least cost method, vogel's approximation method, finding the optimal solution, special cases in transportation problems - unbalanced transportation problem, degeneracy in transportation**UNIT-III****Assignment techniques:** Introduction, Hungarian technique of assignment techniques, unbalanced problems, problems with restrictions, maximization in assignment problems, travelling salesman problems**UNIT-IV****Project management:** Definition, procedure and objectives of project management, differences between CPM and PERT, rules for drawing network diagram, scheduling the activities, Fulkerson's rule, earliest and latest times, determination of ES and EF times in forward path, LS & LF times in backward path, determination of critical path, duration of the project**UNIT-V****Sequencing models:** Introduction, general assumptions in sequencing, sequencing rules processing n jobs through two machines, processing n jobs through three machines

Text Books:

1. Hamdy A. Taha, Operations Research-An Introduction, 10th edition, Pearson education edition, 2017.
2. S.D. Sharma, Operations Research, Kedarnath, Ramnath & Co., Meerut, 2009.
3. V.K. Kapoor, Operations Research, S. Chand Publishers, New Delhi, 2004.

Suggested Reading:

1. R. Paneerselvam, Operations Research, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2008.
2. Nita H. Shah, Ravi M. Gor, Hardik Soni, Operations Research, PHI Learning Private Limited, 2013.

20ME O11**MODERN MANUFACTURING PROCESSES**

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Understand the opportunities and challenges brought about by Industry4.0.
2. Familiarize with the basic concept and process of digital manufacturing.
3. Understand real-life scenarios and recommend the appropriate use of 3D printing technology.
4. Acquire the knowledge of non-traditional machining processes.
5. Learn the procedure for the fabrication of micro-electronic devices.

Outcomes: At the end of the course, the students are able to

1. Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.
2. Apply the concept, architecture and process of digital manufacturing.
3. Evaluate real-life scenarios and recommend the appropriate use of 3D printing technology.
4. Compare various non-traditional machining processes.
5. Demonstrate the procedure for the fabrication of micro-Electronic devices.

UNIT –I

Introduction to industry 4.0: The various industrial revolutions, digitalization and its impact, comparison of industry 4.0 factory and today's factory. business issues in industry 4.0, internet of things (IoT) & industrial internet of things (IIoT) & internet of services, smart manufacturing, cyber physical systems, trends of industrial big data, cloud computing, robotic automation and collaborative robots, cyber security.

UNIT –II

Digital manufacturing process : Introduction to digital manufacturing and design, concepts , research and development status of digital manufacturing, definition, features and development of digital manufacturing, transition to digital manufacturing and design, advantages of digital manufacturing and design. digital thread, information sharing in the digital thread, data procurement standards, manufacturing supply chains, integrated information systems in the product life cycle.

UNIT –III

Additive manufacturing processes: Introduction to 3D printing, evolution, distinction between 3D printing & CNC machining.

Processes and principles: Photo polymerization, powder bed fusion, binder jetting, material jetting, sheet metal lamination, material extrusion, direct energy deposition. application in aerospace industry, automotive industry, jewelry industry, medical and bioengineering applications, planning and simulation of complex surgery, forensic science.

UNIT–IV

Nontraditional machining processes: Requirement, process description of ultrasonic machining, abrasive jet machining, water jet machining, water abrasive jet machining, electro discharge machining, electrochemical machining, chemical machining, ion beam etching, plasma arc machining, laser beam machining and electron beam machining.

UNIT-V

Fabrication of micro- electronic devices: Introduction, semiconductors and silicon, fabrication of integrated circuits and silicon wafers, film deposition, lithography, etching, diffusion and ion implantation, metallization and testing, bonding and packaging, printed circuit boards.

Text Books:

1. Mikell P. Grover, Fundamentals of Modern Manufacturing Materials, Processes and Systems, 4th edition, John wiley & sons, inc, 2009.
2. Zude Zhou, Shane (Shengquan) Xie and DejunChen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
3. Brent Stucker, David Rosen, and Ian Gibson, Additive Manufacturing Technologies, Springer, 2010.

Suggested Reading:

1. Serope Kalpak Jain, Steven R.Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India, 2006
2. Amitabh Ghosh and Mallick, Manufacturing Science, 4th edition, Assoc. East West Press Pvt. Ltd., 2011.

20ME O12**3D PRINTING**

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. To make students understand the basic concept of digital manufacturing.
2. To teach different processes involved in digital fabrication of products.
3. To demonstrate the STL file generation and manipulations.
4. To demonstrate various post processing techniques.
5. To demonstrate the applications of RP in different fields of engineering.

Outcomes: At the end of the course, the students are able to

1. Understand the concept of 3D printing processes, advantages and limitations.
2. Evaluate real-life scenarios and recommend the appropriate 3D printing technology.
3. Analyze various pre-processing and post processing techniques.
4. Explain current and emerging 3D printing technologies in diversified applications.
5. Identify components required in construction of 3D printer.

UNIT-I

Introduction to 3D Printing: Introduction to 3D printing, evolution, distinction between 3D printing & CNC machining.

Design considerations: Materials, size, resolution, mass customization. additive vs. subtractive manufacturing, its advantages and limitations

UNIT-II

Photo polymerization processes: Photo polymerization, Stereolithography Apparatus (SLA), Applications, advantages and disadvantages.

Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Applications, advantage and disadvantages.

Extrusion-based systems: Fused deposition modeling (FDM), laminated object manufacturing (LOM), Principles, Materials, Process Benefits and Drawbacks.

Material Jetting AM Processes: Evolution of Printing as an Additive Manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes.

UNIT-III

Pre processing in AM: Modeling and viewing - 3D scanning; Model preparation – STL conversion, STL error diagnostics, STL file Repairs, generic solution, slicing, newly proposed file formats.

Post processing in AM: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

UNIT-IV

Construction of basic 3D printer: Construction of 3D printing machine – axes, linear motion guide ways, ball screws, motors, bearings, encoders, process chamber, safety interlocks, sensors.

UNIT-V

Applications of AM: Application in aerospace industry, automotive industry, jewelry industry, coin industry. medical and bioengineering applications: planning and simulation of complex surgery, forensic science.

Text Books:

1. Gibson, DW. Rosen and B.Stucker; Additive manufacturing methodologies: Rapid prototyping to direct digital manufacturing, Springer, 2010.
2. Chee Kai Chua, Kah Fai Leong, 3D printing and additive manufacturing: principles and application, 4th edition of rapid proto typing, World scientific publishing company, 2014.
3. P.K. Venuvinod, Rapid prototyping – Laser based and other technologies, Kluwer, 2004.

Suggested Reading:

1. Jacob, Paul, Rapid tooling: Technologies and industrial applications, Taylor & Francis Group, 2000.
2. Alain Bernard, Georges Taillandier, Additive Manufacturing, Wiley, 2014.

20ME O13**INDUSTRIAL AND FINANCIAL MANAGEMENT**

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Various types of business organizations and organization structures. Principles of management and importance of plant location and plant layout.
2. Importance of industrial engineering techniques like method study and work measurement.
3. The significance of quality control and production planning and control.
4. The importance of project management techniques.
5. The total cost of a product based on elements of cost.

Outcomes: At the end of the course, the students are able to

1. Understand different types of business organizations, functions of management and importance of various types of plant layouts.
2. Apply techniques of method study and work measurement in organizations to enhance productivity.
3. Use quality control charts and tools in industries.
4. Apply various optimization and project management techniques for solving real time problems.
5. Understand basic concepts of cost accounting and financial management.

UNIT-I

Industrial organization: definition of an organization, types of various business organizations, organization structures and their relative merits and demerits, functions of management, principles of management.

Plant location and layouts: Factors affecting the location of plant and layout, types of layouts and their merits and demerits.

UNIT-II

Productivity: Definition, concepts, principles and techniques of improving productivity

Work study: Definitions, objectives of method study and time study, steps in conducting method study, symbols and charts used in method study, principles of motion economy, calculation of standard time by time study and work sampling, performance rating factor, types of ratings, Job evaluation and performance appraisal, Wages and incentives plans.

UNIT-III

Inspection and quality control: Types and objectives of inspection, S.Q.C., its principles, quality control charts and sampling plans, quality circles, introduction to ISO and TQM.

Production planning and control (PPC): Types of production systems, Principles of PPC and its functions.

UNIT-IV

Optimization: Introduction to linear programming and graphical solutions.

Project management: Introduction to CPM and PERT, determination of critical path and project duration. **Materials management:** Classification of materials, materials planning, duties of purchase manager, determination of economic ordering quantities.

UNIT-V

Cost accounting: Elements of cost, various costs, types of overheads, break even analysis and its applications, depreciation, methods of calculating depreciation fund, nature of financial management, time value of money, techniques of capital budgeting and methods, cost of capital, financial leverage.

Text Books:

1. O.P. Khanna, Industrial Engineering and Management, Dhanapat Rai & Sons, 2018.
2. S.D. Sharma, Operations Research, Kedarnath, Ramnath & Co., Meerut, 2012.
3. Pandey I.M, Financial Management, Vikas Publ. House, New Delhi, 2016.

Suggested Reading:

1. William J Stevenson, Operations Management, McGraw Hill, 2018.
2. Paneerselvam, Production and Operations Management, Pearson Education, 2012.

20ME O14**PRINCIPLES OF MANAGEMENT**

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives: To make the students to

1. Understand basic fundamentals and insights of management
2. Understand the nature and purpose of planning
3. Gain the knowledge about the frame work of organizing
4. Understand the essence and significance of directing
5. Recognize the importance of controlling and its outcomes

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

1. Identify and evaluate the principles of management
2. Demonstrate the ability to have an effective and realistic planning
3. Identify the nature and the type of organization
4. Apply the tools and techniques of directing
5. Explain and evaluate the necessity for controlling and further refinement of an organization.

UNIT - I

Management: Definition of management, science or art, manager vs entrepreneur; managerial roles and skills, Evolution of management, Basic management theories by FW Taylor, Henry Fayol, Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management

UNIT - II

Planning: Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Planning plant location and layout, Decision making steps & processes.

UNIT - III

Organizing: Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management

UNIT - IV

Directing: Individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

UNIT - V

Controlling: system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Text Books:

1. S.P. Robins and M. Couiter, Management, 10th edition, Prentice Hall India, 2009.
2. JAF Stoner, RE Freeman and DR Gilbert, Management, 6th edition, Pearson Education, 2004.
3. Ramesh B. Rudani, Principles of Management, 2nd edition, McGraw Hill, 2019

Suggested Reading:

1. P.C. Tripathy & P.N. Reddy, Principles of Management, Tata McGraw Hill, 1999.
2. Harold Koontz and Cyril O'Donnell, Principles of Management, Tata McGraw Hill, 2017

20ME O15**PRINCIPLES OF INDUSTRY 4.0**

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Understand the concept and applications of Digital Manufacturing and Industry 4.0.
2. Relate different Additive manufacturing processes as a part of Digital Manufacturing
3. Understand the concept of Virtual prototyping, digital design and Importance of reverse engineering in Digital Manufacturing
4. To understand the concept of Industry 4.0 and allied technologies.
5. To Provide an understanding on the challenges faced and relevant industrial applications of Industry 4.0

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

1. Understand the Basics and applications of Digital Manufacturing and Industry 4.0.
2. Understand the role of Additive Manufacturing, Virtual prototyping and Reverse Engineering processes and their adaptability to Digital Manufacturing.
3. Understand the concepts of digital manufacturing based product life cycle and its management.
4. Understand the concept of Industry 4.0 and allied technologies.
5. Understand the basics of Internet of things and cloud computing pertaining the fourth industrial revolution.

UNIT-I

Introduction to digital manufacturing: Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System, Impact on manufacturing careers, Advantages of digital manufacturing and design, Information sharing in the digital thread, Digital twins and Files format (STL, AMF, 3MF), Multiple organizations in the manufacturing process. Introduction of Industry 4.0, case study on car manufacturing by Bosch.

UNIT-II

Additive Manufacturing Processes: Additive Manufacturing processes – Engineering polymers, metals and ceramics. Stereolithography, Selective Laser Sintering, Fused Deposition Modeling, Layered object manufacturing. Electronic Materials, Bio-printing, Food Printing. Preprocessing and Post processing in AM

Virtual Prototyping & Reverse Engineering: Virtual Prototyping, Applications, Virtual Prototyping and Virtual Manufacturing. Reverse Engineering, Application of Reverse Engineering in Digital Manufacturing. Self-Learning of Manufacturing System and Intelligent Manufacturing System.

UNIT-III:

Key Technology of Digital Manufacturing: Various Digital Technologies in Product Lifecycle, Digital Equipment and Digital Processing Technology, Technology of Digital Maintenance and Diagnosis.

Product life cycle management: Introduction, Types of Product Data, Product life cycle management (PLM) systems. Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

UNIT-IV:

Industry 4.0: Various Industrial Revolutions, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, automation, data exchanges, cloud, cyber-physical systems, mobile robots, Big Data, deep machine learning, Production Systems, IoT, Challenges of implementing Industry 4.0, Impact of implementing Industry 4.0 in various sectors, Applications domains and the way forward.

UNIT –V:

Internet of Things (IoT) - IoT design methods, physical devices and enabling technologies, Industrial Internet of Things (IIoT), Smart Manufacturing.

Cloud Computing and Manufacturing- Cloud models, cloud manufacturing examples, cloud based manufacturing, Cloud service and platforms for manufacturing.

Augmented Reality and Virtual Reality in Manufacturing.

Text Books:

- 1 Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012
- 2 Brent Stucker, David Rosen, and Ian Gibson, Additive Manufacturing Technologies, ISBN 978-1-4419-1120-9, Springer, 2010
- 3 Chee Kai Chua, Kah Fai Leong, 3D printing and additive manufacturing: principles and Application, 4th edition of rapid prototyping
- 4 Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things.

Suggested reading:

1. Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009
2. Venuvinod, PK; Ma, W; Rapid prototyping – Laser based and other technologies, Kluwer, 2004

20ME O16**DESIGN THINKING**

(Open Elective)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Create awareness of design thinking approaches
2. Identify a systematic approach for defining/identifying a problem
3. Create design thinking teams and conduct design thinking sessions collaboratively
4. Apply both critical thinking and design thinking in parallel to solve problems
5. Motivate to apply design thinking concepts to their real life scenarios

Outcomes: At the end of the course, the students are able to

1. Understand design thinking and its phases as a tool of innovation
2. Empathize on the needs of the users
3. Define the problems for stimulating ideation
4. Ideate on problems to propose solutions by working as a design thinking team
5. Prototype and test the proposed solutions focusing on local or global societal problems

UNIT – I

Introduction to Engineering & Thinking: Engineering for social and economic development; impact of science/engineering. Thinking and behaviour; Types of thinking – Linear thinking, lateral thinking, systems thinking, design thinking.

Introduction to Design Thinking: Importance of Design Thinking – Phases in design thinking process, five-stage model, non-linearity of the five-stage model, applications of design thinking in various domains.

UNIT – II

Empathize phase: Understanding the unique needs of the user, empathize with the users, steps in empathize phase, developing empathy towards people, assuming a beginner's mind-set (what? why?), steps in immersion activity, body storming; Case studies.

UNIT – III

Define phase: Define the problem and interpret the result, analysis and synthesis, Personas – Four different perspectives on Personas, steps to creating personas, problem statement, affinity diagrams, empathy mapping; Point of View – “How might we” questions, Why-how laddering; Case studies.

UNIT – IV

Ideation phase: What is ideation, need, uses, ideation methods; Brainstorming, rules for brainstorming; Mind maps, guidelines to create mind maps; Ideation games; Six Thinking Hats; Doodling, use of doodling in expressing creative ideas; Case studies.

UNIT – V

Prototyping phase: Types of prototyping, guidelines for prototyping, storytelling, characteristics of good stories, reaching users through stories, importance of prototyping in design thinking; Value proposition, guidelines to write value proposition; Case studies.

Testing phase: Necessity to test, user feedback, conducting a user test, guidelines for planning a test, how to test, desirable, feasible and viable solutions, iterate phase.

Text Books:

1. Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires*, 1st Edition, HarperCollins, 2009.
2. Michael Luchs, Scott Swan, Abbie Griffin, *Design thinking: New product development essentials from the PDMA*. John Wiley & Sons, 2015.
3. Pavan Soni, *Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving*, Penguin Random House India Private Limited, 2020.

Suggested Reading:

1. Jeanne Liedtka, Andrew King, Kevin Bennett, *Solving problems with design thinking: Ten stories of what works*. Columbia University Press, 2013.
2. Bala Ramadurai, Karmic, *Design Thinking - A Buddhism-Inspired Method to Help Create Human-Centered Products & Services*, 1st edition, 2020.