Department of Mechanical Engineering

CURRICULUM AND SYLLABI

(2023-2027)

B.Tech. Robotics and Automation Engineering

Mechanical Engineering

B.Tech. (RA)

CURRICULUM AND SYLLABI

Vision Statement of University

Be an internationally acclaimed University recognized for its excellent teaching, research, innovation, outreach and creating top class technocrats and professionals who can serve the mankind as multi skilled global citizen.

Mission Statement of University

- Establish state-of-the-art facilities for world class education and research.
- Conduct scholarly research and creative endeavors that impact quality of life.
- Attract quality staff and students to cater for diverse needs and preferences and widen participation.
- Build a foundation for students to be successful at all levels through high-quality, innovative programs.
- Collaborate with institute, industry, and society to address current issues through research and align curriculum.
- Involve in societal outreach programs to identify concerns and provide sustainable ethical solutions.
- Encourage life-long learning and team-based problem solving through an enabling environment.

Vision of the Department:

To develop engineers of par excellence to meet the ever-changing requirements of industries, motivated towards innovation, entrepreneurship and research in mechanical and allied engineering along with strong human values and ethics for the benefit of society and nation at large.

Mission of the Department:

1. To offer a platform to the students where they will be able to groom themselves technically as industry ready professionals.
2. To develop research environment where students will be motivated to enhance their knowledge to undertake research in mechanical and allied engineering.
3. To collaborate with industries, education institutes of excellence and aluminus to share and exchange latest technology and innovation.
4. To design curriculum to motivate and sensitize students towards environmental issues and respect for human values and ethics.
5. To develop conducive academic environment in the department to attract qualified faculties members from all around the country.

Department of Mechanical Engineering

Program Education Objectives (PEOs)

PEO_{01} To provide advanced knowledge for finding solutions of complex practical problems.

PEO_{02} To develop research acumen for designing a system with better efficiency and performance.

PEO_{03} To prepare students as experts with better communication skills, professional ethics and team spirit for working in multidisciplinary teams

Department of Mechanical Engineering
PROGRAMME OUTCOMES (POs)

After the completion of programme, student shall be able to: -

PO01	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO02	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO03	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.
PO04	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO05	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO06	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO07	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of ,and need for sustainable development.
PO08	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO09	**Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Department of Mechanical Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO_{01} Multi-disciplinary Engineering in Robotics: Analyze the real world needs and design the robot and Automation solutions using the competency in multi domain engineering elements and integrated software tools.

PSO_{02} Enhancement and upgradation: Analyze conventional functions and process of various engineering elements and propose robots and automation solution for enhanced performance of conventional systems.

PSO_{03} Robotic system integration and automated Solution and connectivity: Recommend the sensing, interfacing, controlling, actuating, communicating technologies and analyzing the data through various subsystems and build the robots.

Medi-Caps University, Indore
Scheme of B.Tech. -Robotics and Automation Engineering
For the candidates admitted in session 2023-27

Semester I

SR. No.	Course Code	Course Name	L	T	P	Credits
1	EN3BS11	Engineering Mathematics-I	3	0	0	3
2	EN3BS16	Engineering Physics	3	0	2	4
3	EN3ES17	Basic Electrical Engineering	3	0	2	4
4	EN3ES26	Engineering Graphics	2	0	2	3
5	EN3ES27	Basic Programming with C	2	0	2	3
6	EN3ES30	Basic Civil Engineering & Mechanics	3	0	2	4
7	EN3NG01	Environmental Science	2	0	0	2
8	EN3NG02	Universal Human Values & Professional Ethics	2	0	0	2
		Total	**20**	**0**	**10**	**25**
		Total Contact Hours	**30**			

Semester II

S.No.	Course Code	Course Name	L	T	P	Credits
1	EN3BS12	Engineering Mathematics-II	3	0	0	3
2	EN3BS14	Engineering Chemistry	2	0	2	3
3	EN3ES16	Basic Electronics Engineering	3	0	2	4
4	EN3ES18	Basic Mechanical Engineering	3	0	2	4
5	EN3ES28	Advanced Programming with C	2	0	2	3
6	EN3ES29	Engineering Workshop	0	0	2	1
7	EN3HS01	History of Science and Technology	2	0	0	2
8	EN3HS10	Communication Skills	2	0	2	3
		Total	**17**	**0**	**12**	**23**
		Total Contact Hours	**29**			

SEMESTER – III

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	EN3BS15	Engineering Mathematics-III	3	0	0	3
2	RA3CO23	Strength of Materials for Mechanical Engineers	3	0	2	4
3	RA3CO24	Kinematics and Dynamics of Machines	3	0	2	4
4	RA3CO25	Basic of Thermal Engineering	3	0	2	4
5	RA3CO51	Digital Electronics	3	0	2	4
6	RA3CO27	Sensors and Instrumentation	3	0	0	3
7	RA3CO40	CAD Lab	0	0	2	1
8	EN3NG09	Soft Skills -I	2	0	0	2
		Total	**20**	**0**	**10**	**25**
		Total Contact Hours	**30**			

SEMESTER – IV

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	RA3CO43	Design of Machine Elements and Transmission Systems	3	0	2	4
2	RA3CO30	CNC Machine and Metrology	3	0	2	4
3	RA3CO31	Automatic Control Systems	3	0	0	4
4	RA3CO32	Python for Robotics Engineers	3	0	2	4
5	EN3HS04	Fundamentals of Management, Economics & Accountancy	3	0	0	3
6	RA3ELXX	Program Elective - I	3	0	0	3
7	EN3NG10	Soft Skills -II	2	0	0	2
		Total	**20**	**0**	**6**	**24**
		Total Contact Hours	**26**			

L : Lecture T : Tutorial P : Practical

SEMESTER – V

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	RA3CO37	Electrical Machines and Power Systems	3	0	2	4
2	RA3CO48	Principles of Robotics	4	0	2	5
3	RA3CO49	Embedded Systems	3	0	0	3
4	RA3CO50	Digital Image Processing	3	0	2	4
5	RA3ELXX	Program Elective - II	3	0	0	3
6	RA3ELXX	Program Elective - III	3	0	0	3
7	OE000XX	Open Elective- I	3	0	0	3
8	EN3NG05	Soft Skills -III	2	0	0	2
		Total	**24**	**0**	**6**	**27**
		Total Contact Hours	**30**			

SEMESTER – VI

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	RA3CO33	Robot System Design and SLAM (Simultaneous Localization and Area Mapping)	3	0	2	4
2	RA3CO38	Microcontroller and Programmable Logic Controllers	3	0	2	4
3	RA3CO46	Computer Vision	3	0	2	4
4	RA3ELXX	Program Elective - IV	3	0	0	3
5	RA3ELXX	Program Elective - V	3	0	0	3
6	OE000XX	Open Elective -II	3	0	0	3
7	RA3PC11	Mini Project	0	0	4	2
8	EN3NG08	Soft Skills -IV	2	0	0	2
		Total	**20**	**0**	**10**	**25**
		Total Contact Hours	**30**			

SEMESTER – VII

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	RA3ELXX	Program Elective - VI	3	0	0	3
2	OE000XX	Open Elective III	3	0	0	3
3	RA3PC12	Project-1	0	0	8	4
4	RA3PC03	Industrial Training	0	2	0	2
5	EN3NG06	Open Learning courses	1	0	0	1
		Total	**7**	**2**	**8**	**13**
		Total Contact Hours	**17**			

SEMESTER VIII

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	RA3PC13	Project-II	0	0	22	11
		Total	**0**	**0**	**22**	**11**
		Total Contact Hours	**22**			

Total Credits with NG Courses	**173**

Summary of Credits

Sr.No.	Course Work	Total Credits	Credits as per Modal scheme
1	Basic Sciences (BS)	16	10-15% (16-24)
2	Engineering Sciences (ES)	26	15-20% (24-32)
3	Humanities and Social Sciences (HS)	8	5-10% (8-16)
4	Core (CO)	64	30-40% (48-64)
5	Program Electives (EL)	18	10-15% (16-24)
6	Open Electives (OE)	9	5-10% (8-16)
7	Project Work, Industrial Training	19	10-15% (16-24)
8	Non-Grading	13	
		173	

MEDI-CAPS UNIVERSITY

Department of Mechanical Engineering

Choice Based Credit System- Scheme of B.Tech. RA (2023 Batch)

SEMESTER I

Sr. No.	Course Code	Courses	L	T	P	Credit
1	EN3BS11	Engineering Mathematics-I	3	0	0	3
2	EN3BS16	Engineering Physics	3	0	2	4
3	EN3ES17	Basic Electrical Engineering	3	0	2	4
4	EN3ES26	Engineering Graphics	2	0	2	3
5	EN3ES27	Basic Programming with C	2	0	2	3
6	EN3ES30	Basic Civil Engineering & Mechanics	3	0	2	4
7	EN3NG01	Environmental Science	2	0	0	2
8	EN3HS01	History of Science and Technology	2	0	0	2
		Total	**20**	**0**	**10**	**25**
		Total Contact Hours	**30**			

SEMESTER II

Sr. No.	Course Code	Courses	L	T	P	Credit
1	EN3BS12	Engineering Mathematics-II	3	0	0	3
2	EN3BS14	Engineering Chemistry	2	0	2	3
3	EN3ES16	Basic Electronics Engineering	3	0	2	4
4	EN3ES18	Basic Mechanical Engineering	3	0	2	4
5	EN3ES28	Advanced Programming with C	2	0	2	3
6	EN3ES29	Engineering Workshop	0	0	2	1
7	EN3NG02	Universal Human Values & Professional Ethics	2	0	0	2
8	EN3HS10	Communication Skills	2	0	2	3
		Total	**17**	**0**	**12**	**23**
		Total Contact Hours	**29**			

Course Code	Course Name	Hours per week			Total	
		L	T	P	Hours	Credit
EN3BS11	**Engineering Mathematics-I**	**3**	**0**	**0**	**3**	**3**

Course Learning Objectives (CLOs):

CLO01 To impart analytical ability of using concepts of matrices in various fields of engineering.

CLO02 To explain the concept of Differential Calculus.

CLO03 To discuss the concept of Integral Calculus and its applications.

CLO04 To impart analytical ability in solving Ordinary Differential Equations of first and Higher order.

CLO05 To impart basics of complex number and variables including concepts of analytical functions.

Unit I Matrices and Linear Systems

Rank and Nullity of a Matrix by reducing it into Echelon and Normal Forms, Solution of Simultaneous equations by elementary transformation methods, Consistency and Inconsistency of Equations, Eigen Values and Eigen Vectors.

Unit II Differential Calculus

Introduction to limit continuity, differentiability, Rolle's theorem, Mean value theorem, Taylors and Maclaurin's series expansions. Functions of Several variables, Partial differentiation, Euler's Theorem, Total Derivative, Maxima and Minima of function of two variables.

Unit III Integral Calculus

Definite Integral as a limit of sum and its application in summation of series, Beta and Gamma functions (Definitions, Relation between Beta and Gamma functions without proof, Duplication formula without proof). Multiple Integral (Double and Triple Integrals), Change the Order of Integration, Applications of Multiple Integral in Area, Volume.

Unit IV Ordinary Differential Equations

First order differential equations (Separable, Exact, Homogeneous, Linear), Linear differential Equations of second and higher order with constant coefficients**,** Homogeneous linear differential equations, Simultaneous linear differential equations**.**

Unit V Complex Variable

Basics of Complex number, Functions of complex variable: Analytic functions, Harmonic Conjugate functions, Cauchy-Riemann Equations, Complex Line Integral, Cauchy's Theorem, Cauchy's Integral Formula.

Text books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi.
2. H.K. Dass, *Higher Engineering Mathematics, S. Chand & Company Pvt LTD., New Delhi*

References:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Pub. Co. Ltd., New Delhi.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. R.K. Jain and S.K. Iyengar, Advanced Engineering Mathematics, Narosa Pub. House, New- Delhi.

Web Source:

1. http://nptel.ac.in/courses/111108066/
2. http://nptel.ac.in/courses/111104085/
3. https://swayam.gov.in/courses/public
4. http://nptel.ac.in/course.ph

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To illustrate the tools of matrices in solving the system of simultaneous equations,

CO_{02} To investigate the tools of differential calculus to relevant fields of engineering and can implement the concept of several variables.

CO_{03} To relate the integral calculus to relevant fields of engineering and can translate the concept of multiple integrals in finding area of regions and volume of solids.

CO_{04} To solve Ordinary Differential Equations using different methods.

CO_{05} To relate the knowledge of complex number and categorize it in solving functions of several complex numbers.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3BS16	Engineering Physics	3	0	2	4

Course Learning Objectives (CLOs):

CLO01	Understand the concept of Quantum Mechanics.
CLO02	Know about the optical phenomenon like Interference, diffraction, and polarization with their use in daily life.
CLO03	Learn and understand about the concept of nuclear size, shape, and its various properties.
CLO04	Understand the concept of crystal structure and its basics.
CLO05	Learn about the solid-state Physics and concept of the superconductivity.
CLO06	Gain Knowledge of about concepts and application of Laser and Optical fibre.

Unit-I Quantum mechanics

Limitations of Classical Mechanics, De-Broglie hypothesis for matter waves, Phase and group velocity, wave packet, Heisenberg's uncertainty principle, Compton scattering, wave function, Schrodinger's Time dependent and time independent wave equation, Particle in a box problem.

Unit-II Wave Optics

Interference: Fresnel's biprism experiment, Newton's ring experiment. Diffraction of light: Fraunhofer diffraction for single slit, Grating and its types, and Rayleigh criterion of Resolution. Polarization: General concept of Polarization, Huygens theory of double refraction, Engineering Applications of Polarization.

Unit-III Nuclear Physics

Nuclear Structure, Nuclear model: Liquid drop model, Semi- empirical mass formula (Qualitative study) , Shell model, Particle accelerators: LINAC, Cyclotron, Synchrotron (Qualitative study), Betatron. Geiger-Muller (GM) counter, Bainbridge Mass Spectrograph.

Unit-IV Solid State Physics

Crystal Physics: Unit cell, Crystal System, Types of Unit cell: Simple cubic, Face centred cubic, Body centred cubic Crystal, Number of atoms per unit cell, Packing fraction in different cubic lattices, Miller indices. Band theory of solids: Free Electron model, Band Model, Fermi level for Intrinsic and Extrinsic Semiconductors, Hall effect. Superconductivity: Zero resistance, persistent currents, superconducting transition temperature (Tc), Meissner effect, Type-I and Type-II superconductors, Engineering applications of superconductivity.

Unit-V: Laser and Fiber Optics

Lasers: Properties of lasers, Spontaneous and Stimulated emission of radiation, Einstein's A & B coefficient, Population inversion, Components of Laser, Ruby Laser, He-Ne Laser, Engineering applications of lasers. Fiber Optics: Fundamental idea about optical fibre, propagation of light through optical fibre acceptance angle, numerical aperture, fractional refractive index change, Classification of fibre, V number, Engineering applications of fibre.

Textbooks:

1. A Text book of Optics, N. Subramanyam and Brij Lal, S. Chand , New Delhi, 2010 .
2. Engineering Physics, H. K. Malik and A. K. Singh, Tata McGraw Hill New Delhi, 2010
3. Concepts of Modern Physics A. Beiser, Tata McGraw Hill New Delhi.
4. Engineering Physics, Gaur and Gupta, Dhanpat Rai Publications.

References:

1. An Introduction to Lasers- Theory and Applications. Dr. M N. Avadhanulu, Dr. R. S. Hemne S. Chand Publications.
2. Optics, A. Ghatak: 4th Edition, Tata McGraw-Hill, New Delhi 2009.
3. An Introduction to Fiber Optics, Ghatak and Thiagarajan, Cambridge University Press.
4. Solid State Physics by Kittel, Wiley India
5. A Text book of Physics – N. Gupta & S.K. Tiwary, Dhanpat Rai & Co., Delhi
6. Quantum Mechanics by Ghatak & Loknathan, Macmillian India Ltd-new Delhi Revised Edition 2019.

List of Practical's List of suggestive core experiments (Any 10 experiments from the list of 15)

Quantum Mechanics

1. Determination of Planck's constant (h) using light emitting diode (LED) of various colors.
2. To study black body Radiation by PhET Simulation.

Wave Optics

3. To determine the radius of curvature of plano convex lens using Newton's ring experiment.
4. To determine wavelength of spectral lines of mercury vapor lamp with the help of grating an
    a. spectrometer.
5. To determine the specific optical rotation of sugar solution by biquartz polarimeter.
6. To determine the wavelength of given sodium vapor lamp using Fresnel's Biprism.

Nuclear Physics

7. To understand Rutherford scattering using Ph ET Simulation module.
8. Determining the specific charge of the electron **Solid State Physics**
9. To study the Hall Effect experiment and calculate the charge carrier concentration (density) of given semiconductor diode.

10. To determine the energy band gap of semiconductor diode.
11. To study V-I characteristics of semiconductor diode and Zener diode.

Laser and Fiber Optics

12. To measure the beam divergence and beam waist of laser beam.
13. To measure the numerical aperture of an optical fiber by scanning method.
14. To find the thickness of thin wire using laser.
15. To establish a fiber optic analog link and study of bending loss in optical fiber.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} : Gain a solid understanding of the fundamental principles and postulates Of quantum mechanics.

CO_{02} : Understand the principle of Interference, diffraction, and polarization.

CO_{03} : Learn and understand about the concept of nuclear size, model and it's Various types of accelerators.

CO_{04} :Understand the electrical behaviour of electrons in solids using model.

CO_{05} :Acquire and analyse the knowledge of Crystal structure and Solid-state Physics.

CO_{06} :Understand the basic principles of various laser and optical fibres.

Course Code	Course Name	Hours per week			Total	
		L	T	P	Hours	Credits
EN3ES17	**Basic Electrical Engineering**	**3**	**0**	**2**	**5**	**4**

Course Learning Objectives (CLOs):

CLO_{01} To introduce fundamental concepts and analysis techniques in electrical engineering to students across all disciplines.

CLO_{02} To introduce the students about domestic wiring, the functioning of various electrical apparatus and the safety measures. Emphasize the effects of electric shock and precautionary measures.

CLO_{03} To impart basic knowledge of electrical quantities such as current, voltage, power, energy, and frequency to understand the impact of technology in a global and societal context.

CLO_{04} To provide knowledge about the basic DC and AC electric circuits and magnetic circuits.

CLO_{05} To introduce the concepts of power supply, UPS, SMPS, motors, transformers, and their applications.

Unit-I: DC circuit analysis

Elements and characteristics of electric circuits, ideal and practical sources, independent and dependent electrical sources, Ohm's law, source transformation, Kirchhoff's laws. Mesh analysis, nodal analysis, voltage and current division rules, star-delta conversions, Thevenin's and Norton's theorems.

Unit-II: AC Circuit Analysis

Generation of sinusoidal AC voltage, average and RMS values, concept of phasor, analysis of series RL, RC and RLC circuits, power triangle, power factor, series resonance and Q factor. Generation of three phase voltages, advantages of three phase systems, star and delta connections (balanced only), relation between line and phase quantities.

Unit-III: Electrical Machines

Definition, working principle and construction of transformer, construction & working principle of DC motor and three phase induction motor, single phase induction motor, application of rotating machines.

Unit-IV: Industrial Electrical Engineering

Power supply: linear power supply, switch mode power supply (SMPS), block diagram of UPS.

Safety and protection: electric hazards and precautions, earthing, fuses, MCB, types of wires and cables, components of domestic wiring, electricity metering and billing.

Unit-V: Electrical Energy Systems and Utilization

Power generation to distribution through overhead lines and underground cables with single line diagram, block schematic representation of hydroelectric and thermal power plants.

Advantages of electrical heating, induction heating and its applications, dielectric heating and its applications, welding transformer.

Textbooks:

1. V.N. Mittal & Mittle, Basic Electrical Engineering, Tata McGraw - Hill
2. D.P. Kothari and I. J, Nagrath, Basic Electrical Engineering, Tata McGraw - Hill.
3. C. L. Wadhwa, Generation, Distribution and Utilization of Electrical Power, Wiley Eastern Ltd., New Delhi.

References:

1. Ashfaq Hussain, Electrical power systems, CBS, Publication
2. D. C. kulshreshtha, Basic Electrical Engineering, McGraw Hill Education.
3. Hemant Joshi, Residential, commercial and industrial electrical systems, Volume-1 (equipment and selection), Tata McGraw – Hill.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01}	Demonstrate an understanding of the basic knowledge of electrical quantities such as current, voltage, power, energy, and frequency to understand the impact of technology in a global and societal context.
CO_{02}	Demonstrate an understanding of basic concepts of analysis of simple DC and AC circuits used in electrical engineering.
CO_{03}	Demonstrate an understanding of power supply, UPS, type of motors and their applications.
CO_{04}	Demonstrate an understanding of basic concepts of transformers, power system components and their application in transmission and distribution of electric power system.
CO_{05}	Demonstrate an understanding of the effects of electric shock and precautionary measures.

List of Experiments

1. To study various electric hazards and corresponding precautions.
2. To verify KCL and KVL.
3. To verify Thevenin's and Norton's theorem.
4. Determination of resistance, inductance, capacitance and power factor of R-L, R-C & R-L-C series circuits.
5. To measure active power, reactive power & apparent power of a single-phase AC circuit.
6. To verify relation between line and phase quantities in a three-phase system.
7. To determine ratio and polarity of single-phase transformer.
8. To study construction of DC machine and three-phase induction motor.
9. To find out fusing factor and plot characteristic of fuse.
10. Study of different components of domestic wiring.
11. Preparation of energy bill based on energy consumption of residence/ Institute.
12. To study welding transformer and its accessories.

Course Code	Course Name	Hours Per Week				
		L	**T**	**P**	**Hrs.**	**Credits**
EN3ES26	Engineering Graphics	2	0	2	4	3

Course Learning Objectives:

CLO1 To familiarize with the principle of orthographic projection, points and lines.

CLO2 To familiarize with the projection of 2D and 3D elements

CLO3 To familiarize with the projection, sectioning and development of solids.

CLO4 To familiarize with the AUTOCAD Drawing Software and its use.

CLO5 To familiarize with the advanced commands of AUTOCAD and their uses.

Unit –I

Orthographic Projection of Point and line

Introduction of orthographic projection: Reference planes, types of orthographic projections– First angle projections, Third angle projection.

Projections of points: Including points in all four quadrants

Projections of lines: Line parallel to reference plane, perpendicular to reference plane, inclined to one reference plane, inclined to both reference planes, traces of line.

Unit-II

Orthographic Projection of Planes and solids

Orthographic Projections of Planes: Projections of Planes in different Positions

Orthographic Projection of Solids: Classification of solid. Projections in simple and complex positions of the axis of the solid.

Unit-III

Section of solids and development of surfaces

Sections of Solids: Sectional views and true shape of the section.

Development of Surfaces: Prism, Pyramid, Cone and Cylinder.

Unit-IV

Introduction to Auto CAD and its basic commands

User Interface – Menu system – coordinate systems, axesTool bars (draw, modify, annotations, layers, Blocks etc.) Status bar (ortho, grid, snap, iso etc.), Utility commands.

Drawing Tools : Line, polyline, Circle, arc Rectangle, polygon Ellipse, Elliptical arc, spline Spline Edit, Xline, Ray, Points Measure, Divide , Donut, , hatch, Gradient, CAD, advantages and limitation of auto cad.

Unit-V

Some advance commands of auto cad and orthographic projection using auto cad

Advance commands: Annotations Dimensions, dimension setting Linear dimension, Aligned dimension, Angular dimensions, arc length, Radius Diameter, ordinates, jogged Base line dimension, Dim base Continuous dimension TEXT: Text style, single text, multi text

TOOLS Property: color, line type, Line weight, Match properties

LAYERS Create layers, Edit layers properties Layer control (hide, freeze, lock Layout lock, print lock)

Orthographic Projection using Auto CAD: Various Objects (Conversion of Pictorial Views to Orthographic Views)

Text Books:

- N.D. Bhatt, Elementary Engineering Drawing, Chartor Publishing House.
- D. N. Johle, Engineering Drawing, Tata Mcgraw-hill Publishing Co. Ltd.
- P.S. Gill, Engineering Graphics, S.K. Kataria and Sons.
- Warren J. Luzzader, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi.
- F. E. Giesecke, A. Mitchell & others, Principles of Engineering Graphics, Maxwell McMillan Publishing.
- K.C. John, Engineering Graphics for Degree, PHI Learning Pvt. Ltd.

References:

- Engineering Drawing- Basant Agarwal, TMH
- D. M. Kulkarni, A. P. Rastogi, and A. K. Sarkar (2009), Engineering Graphics with AutoCAD,PHI Learning Private Limited, New Delhi
- Venugopal (2010), Engineering Drawing and Graphics, 2nd edition, New Age Publications, New Delhi.
- Trymbaka Murthy (2007), Computer Aided Engineering Drawing, I.K. International Publishers,New Delhi.
- R.B. Choudary (2005), Engineering graphics with Auto CAD, Anuradha Publishers,New Delhi

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Familiarize with different drawing equipment's and technical standards. Create and read an engineering drawing using standard views and have ability to Convert

pictorial (3D) drawings to orthographic (2-D) drawings. Understand the projection of points, straight lines and have the ability to convert the practical problems in to projections

CO_{02} To understand and apply concepts of the projection of simple planes & solids.

CO_{03} Understand and apply the concepts of Projection, Sections and development of solids

CO_{04} To understand basic commands of AUTOCAD and its use.

CO_{05} Convert simple 2D orthographic projections into 3D isometric projections with the help of auto cad commands

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3ES27	Basic Programming with C	2	0	2	3

Course Learning Objectives (CLOs):

CLO01 Analyse Basics of Computers, programming environment and about different types of Programming languages.

CLO02 Application of various basic concepts required to create programs, use good problem-solving approach.

CLO03 Use different control structures for conditional programming.

CLO04 Use of Arrays and string in different problems and also to apply different operations on arrays and strings.

CLO05 Use the functions and procedures to solve different problems.

Unit-I Introduction to Computer and Problem-Solving Methodology

Computer System, Computing Environments, Software, Types of Software and Features of Software.

Design Tools (Algorithm, Flow-Chart, Pseudo-Code). Types and Generations of Programming Languages. Compiler, Interpreter, Linker, Loader, Execution of Program. Develop an Algorithm for Simple Problems.

Unit-II Basics of Language

Character set, Identifier, Keywords, Constants, Data Types, Preprocessor Directives, Variables and Declaration, White Space and Escape Sequence, Operators and Expressions, Type Conversions, Operator Precedence and Associativity, Expression Evaluation, Input and Output Functions. Computational Problems Solving Based on above Constructs.

Unit-III Control Statements

Selection (If, Else), Conditional Operator, Iteration (For, While, Do-While), Branching (Switch, Break, Continue, Goto), Nesting of Control Statements. Problem Solving Based on Control Statements.

Unit-IV Arrays and Strings

Defining an Array, One Dimensional Array, Two-Dimensional Array, Multi-Dimensional Array. Basic Array Operations and Matrix Manipulation Operations (Addition, Subtraction,

and Multiplication). Problem Solving Based on Array.

Strings Definition, String Operations and String Functions. Problem Solving Based on Strings.

Unit-V Functions

Introduction, Functions Declaration, Definition, Calling, Return Statement, Parameter Passing (By Value), Recursion, Library Functions. Problem Solving Based on Functions.

Text Books:

1. Herbert Schildt, C: The complete Reference, Fourth Edition, Mc-GrawHill.
2. R. Sethi, Programming Language Concepts and Constructs, Pearson Education.
3. V. Rajaraman, Computer Programming in 'C',PHI.
4. M. Sprankle, Programming and Problem Solving, Pearson Education.
5. R.G. Dromey, How to solve it by Computer, Pearson Education.
6. E. Balguruswamy, Programming in ANSI C by, Tata Mc-GrawHill.
7. Yashavant Kanetkar, Let Us C, BPB.
8. E.Balagurusamy, Fundamentals of Computers, TMH.

References:

1. Kernighan and Ritchie , The 'C' programming language, PHI
2. Programming With C, Schaum Series.
3. A. N. Kamthane, Programming with ANSI and Turbo C, Pearson Education.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Understand Basics of Computers and Programming languages.

CO_{02} Understand basic concepts of C programming language required to create programs.

CO_{03} Apply different types of control structures in problem solving.

CO_{04} Use of Arrays and string in different problems and also to apply different operations on arrays and strings.

CO_{05} Apply and use the functions and procedures to solve different problems.

List of Practical

1. Write a program to print hello user on output screen.
2. Write a program to perform arithmetic operation on two numbers.
3. Write a program to find sum of individual digits of any three digits number.
4. Write a program to print any three-digit number in reverse order.

5. Write a program to swap any two numbers using third variable and without using third variable.

6. Write a program to check given number is even or odd.

7. Write a program to check given char is vowel or consonant.

8. Write a program to check given number is positive or negative.

9. Write a program to check given year is leap year or not.

10. Write a program to check given number in range of 100-200 or not.

11. Write a program to check given number is palindrome or not.

12. Write a program to print grade of student on the basis of percentage:

a. If per greater than or equal to 75 □ A grade
b. If per between 60-75 □ B grade
c. If per between 50-60 □ C grade
d. If per between 40-50 □ D grade
e. If per less than 40 □ Fail

13. Write a program for addition subtraction multiplication division using switch case.

14. Write a program to print table of any number.

15. Write a program to calculate factorial of any number.

16. Write a program to print series of alphabet.

17. Write a program to print Fibonacci series.

18. Write a program to check given number is perfect or not

19. Write a program to check given number is prime or not.

20. Write a program to check given number is Armstrong or not

21. Write a program to print number in word in between 1-5. Like (1 =one)

22. Write a program to check given char is vowel or consonant.

23. Write a program to print name of month according to number.

24. Write a program for convertor.
    - For currency convertor
    - For temperature convertor
    - For weight convertor
    - For length convertor
    - For time convertor
    - For energy convertor
25. Write a program to print series of number from 1-100 without using loop.
26. Write a program to find maximum & minimum number from array.
27. Write a program to check how many numbers is prime & not prime in a list
28. Write a program to check how many digits at each index of array.
29. Write a program to check (search) given number is present or not present in list.
30. Write a program to arrange (sort) array elements in ascending or descending order.
31. Write a program to print a 2*2 matrix.
32. Write a program to find sum of two matrix.
33. Write a program to find multiplication of two matrix.
34. Write a program of string functions.
35. Write a function to find sum of two numbers.
36. Write a function to calculate factorial of any number.
37. Write a function for call by value to find sum of two numbers.
38. Write a function to pass an integer array as an argument and find sum of array elements
39. Write a function to pass a char array as an argument and find length of string.
40. Write a recursive function to calculate factorial of any number.
41. Write a program to find the no of char no of word and no of lines from given text input.

Course Code	Course Name	Hours per Week			Total	Total
		L	**T**	**P**	**Hrs.**	**Credits**
EN3ES30	Basic Civil Engineering & Mechanics	3	0	2	5	4

Course Learning Objectives (CLOs):

CLO01 To understand the utility of various types of building materials.

CLO02 To determine the location of object on ground surface.

CLO03 To understand the location, construction detail and suitability of various building elements.

CLO04 To understand the effects of system of forces on rigid body in static conditions.

CLO05 Analysis of determinate structure (beam & truss).

Unit- I Building Materials & Construction

Stones, bricks, cement, lime, timber-types, properties, test & uses, laboratory tests concrete and mortar Materials: Workability, Strength properties of Concrete, Nominal proportion of Concrete preparation of concrete, compaction, curing.

Elements of Building Construction, Foundations conventional spread footings, RCC footings, floors, staircases – types and their suitability

Unit II Surveying & Levelling

Surveying-classification, general principles of surveying–Basic terms and definitions of chain, Chain survey, Compass survey and levelling.

Unit III Mapping & Sensing

Mapping details and contouring, Profile Cross sectioning and measurement of areas, volumes, application of measurements in quantity computations, Survey stations.

Unit IV Forces & its applications

Graphical and Analytical Treatment of Concurrent and nonconcurrent Co- planner forces, Free Body Diagram, Force Diagram and Bow's notations.

Application of Equilibrium Concepts: Analysis of plane Trusses: Method of joints, Method of Sections. Frictional force in equilibrium problems.

Unit-V Shear force and Bending moment

Introduction of shear force and bending moment and their sign conventions, Types of loads, Types of beams, Types of supports; Shear force and bending moment diagrams for simply supported, overhang and cantilever beams subjected to any combination of point loads, uniformly distributed load, and point moment; Relationship between load, shear force and bending moment.

Textbooks

1.S.C. Rangwala, Building materials, Charotar Publishing House, Pvt. Limited.
2. S. Ramamrutham , BasicCivil Engineering and Engineering Mechanics, Dhanpat Rai.
3. K. K. Dwivedi & K.K. Shukla, Basic Civil Engineering & Engineering Mechanics, Dhanpat Rai & Co.2017 (Revised).

References:

I. K. V. B. Raju and P. T. Ravichandran, Basics of Civil Engineering, Ayyappa Publications, Chennai, 2012.
2. S. Gopi, Basic Civil Engineering, Pearson Publishers, 2009.
3. M. S. Palanichamy, Basic Civil Engineering, Tata McGraw Hill.

Course Outcomes (COs)

After completion of this course the students shall be able to:

CO1: Understand concepts and terminologies of building, Construction materials, surveying and mechanics.

CO2: Apply various methods for surveying and mechanics.

CO3: Determine the location, area and volume of ground.

CO4: Solve the problems of surveying and mechanics by using various methods.

CO5: Analyse the effects of system of forces on rigid bodies in static conditions.

List of Practicals:

1. To determine particle size distribution & fineness modulus of coarse and fine aggregates.

2. To determine standard consistency, Initial & Final Setting time of cement paste using Vicat's Apparatus.
3. To determine the workability of fresh concrete of given proportion by slump cone test.
4. To determine the Crushing Strength of Brick by using CTM.
5. To determine the Compressive Strength of Concrete Sample by CTM.
6. To determine the area of land by chain surveying.
7. To perform traverse surveying with prismatic compass check for local attractionand determine corrected bearing and to balance the traversing by Included Angle Method.
8. To perform levelling by height of Instrument & Rise and Fall method.
9. To find the support reactions of a given truss and verify analytically.
10. To perform Plane Table Surveying work by radiation method.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3NG01	Environmental Science	2	0	0	2

Course Learning Objectives (CLOs):

CLO_{01} To impart knowledge of Environment and its basic components.

CLO_{02} To build basic understanding of various effects of human activities to the environment.

CLO_{03} To understand concepts of water pollution

CLO_{04} To understand function of solid waste management

CLO_{05} To learn concepts of disaster management

Unit-I Ecosystem and Biodiversity

Concept of Ecosystem, Food Chains, Food Webs, Energy flow in an ecosystem.

Biodiversity**:** Introduction, Types, Significance and Conservation.

Unit-II Air Pollution

Causes, Effects and Control of Air Pollution, Greenhouse Effect - Climate changes and Global warming, Ozone layer depletion, Acid Rain.

Case studies on recent cases of air pollution and management.

Unit-III Water Pollution

Causes, Effects and Control of Water Pollution, DO, BOD and COD, Water sampling, Municipal water treatment.

Unit-IV Solid Waste Management

Introduction, Types of solid waste, Harmful effects of solid waste, Methods to manage and modern techniques for solid waste management.

Unit-V Disaster Management

Concept of Disaster, Types of Disaster, Pre-disaster risk and vulnerability reduction, Post disaster recovery and rehabilitation.

Case studies on recent disasters and management.

Textbooks:

1. Preeti Jain, S.L.Garg, K.G.Garg, Energy, Environment, Ecology and Society, Variety Publication.
2. Surinder Deswal, Environmental Science, Dhanpat Rai & Co. publication.
3. R. Rajgopalan , Environmental Studies, Oxford IBH Publication.

References:

1. G. M. Masters, Introduction to Environmental Science and Engineering, Pearson Education Pvt. Ltd.
2. K. De, Environmental Chemistry, New Age International.
3. Daniel D. Chiras, Environmental Science, Jones & Bartlett Ltd.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO01 Gain knowledge of Ecosystem & Biodiversity.

CO02 Develop basic understanding of air pollution and its control method

CO03 Develop basic understanding of water pollution and its control method

CO04 Gain knowledge of Solid waste management and its importance.

CO05 Gain knowledge of Disaster Management.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3HS01	History of Science and Technology	2	0	0	2

Course Learning Objectives (CLOs):

CLO01 To know the historical perspective of science and technology in India, its roots and its role.

CLO02 To know how research and development field is progressing in India.

CLO03 To know what were the policies and plans are proposed after independence to be technologically sound.

CLO04 To Know what were the developments done in major areas of science & technology.

CLO05 To know the relationship between the technologies.

Unit-I Historical Perspective

Nature of science and technology, Roots of science and technology in India, Role of Scienceand Scientists in society, Science and Faith.

Unit-II Research and Development (R&D) in India

Science and Technology Education, Research activities and promotion of technology development, Technology mission, Programs aimed at technological self-reliance, activities of council of scientific and industrial research (CSIR).

Unit-III Policies and Plans after Independence

Nehru's vision of science for independent India, Science and technology developments in the new era, science and technology developments during the Five-Year Plan Periods and scienceand technology policy resolutions.

Unit-IV Science and Technological Developments in Major Areas

Space – Objectives of space programs, Geostationary Satellite Services – INSAT system and INSAT services remote sensing applications, Launch Vehicle Technology. Ocean Development. Objectives of ocean development, marine research. Biotechnology - Applications of biotechnology in medicine, agriculture, food, and fuel. Energy – Research and development in the field of nonconventional energy resources, India's nuclear energy program.

Unit-V Nexus between Technologies

Transfer of Technology – Types, Methods, Mechanisms, Process, Channels and Techniques, Appropriate technology, Technology assessment, Technological forecasting, Technological innovations and barriers of technological change.

Textbooks:

1. K. Rajaram, Science and Technology in India, Published and Distributed by SpectrumBooks (P) Ltd., New Delhi.
2. M. Srinivasan, Management of Science and Technology (Problems & Prospects),East- West Press (P) Ltd., New Delhi.
3. G.R. Kohili, The Role and Impact of Science and Technology in the Development ofIndia, Surjeet Publications.
4. Government of India, Five Year Plans, Planning Commission, New Delhi.
5. K.D. Sharma, and M.A. Qureshi, Science, Technology and Development, SterlingPublications (P) Ltd., New Delhi.

References:

1. Suvobrata Sarkar , History of Science, Technology, Environment, and Medicine in India, Published by Routledge India.
2. Sabareesh P.A. , A Brief History Of Science In India. Published by Garuda rakashan.
3. G. Kuppuram, K. Kumudamani, History of Science and Technology in India, Published by Sundeep Prakashan.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Student will be aware about the ancient India & the existence of science & technology in that era & how it is reciprocated.

CO_{02} Student will be aware about the upliftment done in the field of R & D after independence.

CO_{03} Student will come to know about the plans and policies that brought about radical changes for the growth of science in India.

CO_{04} Student will come to know about the major areas of the applied science and their existence. And can set the relationship between the technologies.

CO_{05} Students will understand the need of technology transfer, its types and processes.

SEMESTER II

Sr. No.	Course Code	Courses	L	T	P	Credit
1	EN3BS12	Engineering Mathematics-II	3	0	0	3
2	EN3BS14	Engineering Chemistry	2	0	2	3
3	EN3ES16	Basic Electronics Engineering	3	0	2	4
4	EN3ES18	Basic Mechanical Engineering	3	0	2	4
5	EN3ES28	Advanced Programming with C	2	0	2	3
6	EN3ES29	Engineering Workshop	0	0	2	1
7	EN3NG02	Universal Human Values and Professional Ethics	2	0	0	2
8	EN3HS02	Communication Skills	2	0	2	3
		Total	**17**	**0**	**12**	**23**
		Total Contact Hours	**29**			

Course Code	Course Name	Hours per week			Total	
		L	T	P	Hours	Credit
EN3BS12	**Engineering Mathematics-II**	**3**	**0**	**0**	**3**	**3**

Course Learning Objectives (CLOs):

CLO_{01} To illustrate knowledge of Laplace Transform and investigate its application.

CLO_{02} To explain the concept of Fourier Series and Fourier Transform.

CLO_{03} To illustrate the concept of Partial Differential Equations.

CLO_{04} To impart the knowledge of Vector Calculus.

CLO_{05} To discuss numerical methods and to outline its application in solving algebraic, transcendental equations and system of linear equations.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO1 To impact mathematical models involving ordinary and partial differential equations with given boundary condition which is helpful in all engineering and research work.

CO2 To examine the general mathematical concepts required for the field regarding Laplace and Fourier Transform.

CO3 To compare and contrast importance of partial differential equations in physical problems.

CO4 To prioritize derivatives of vector- point functions, gradient functions, evaluate integral of functions over curves, surfaces and domains in two and three dimensional.

CO5 To examine numerical techniques and investigate its application in solving algebraic and transcendental equations.

Unit I Laplace Transform

Introduction of Laplace Transform, Laplace Transform of elementary functions, properties of Laplace Transform, Inverse Laplace transform and its properties, Convolution theorem, Applications of Laplace Transform to solve the Ordinary Differential Equation, Laplace transform of

Unit step function and Impulse function.

Unit II Fourier Series and Fourier Transform

Introduction of Fourier series, Fourier series for Discontinuous functions, Fourier series for Even and Odd function, Half range series, Fourier Transform, Sine and Cosine Transform.

Unit III Partial Differential Equations

Definition, Formulation, Solution of Partial Differential Equations (By Direct Integration Method and Lagrange's Method), Non-Linear Partial Differential Equations of First order {Standard form I, II, III & IV), Charpit's method. Partial Differential Equations with Constant Coefficients (Higher Orders Homogeneous), Method of Separation of Variables.

Unit IV Vector Calculus

Scalar and Vector fields, Vector Differentiation, Laplacian operator, Gradient, Divergence and Curl, Line and surface integrals, Green's theorem, Gauss Divergence theorem, Stoke's theorem.

Unit V Numerical Analysis

Errors and Approximations, Solution of Algebraic and Transcendental Equations (Regula Falsi, Newton-Raphson and Iterative methods), Solution of Simultaneous linear equations by Gauss Elimination, Gauss Jordan, Jacobi's and Gauss-Siedel Iterative methods.

Textbooks:

1. B.S. Grewal, *Higher Engineering Mathematics*, Edition-43, Khanna Publishers, New Delhi.
2. H. K. Dass, *Higher Engineering Mathematics,S. Chand & Company Pvt LTD., New Delhi*

References:

1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing CompanyLtd., New Delhi.
2. Shanti Narayan, A textbook of Vector Calculus, S. Chand & Co., New Delhi.
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons 1999.

Web Source:

1. nptel.ac.in/*courses/111103021*/15
2. nptel.ac.in/courses/111105035/22
3. https://swayam.gov.in/courses/public
4. http://nptel.ac.in/course.php

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3BS14	Engineering Chemistry	2	0	2	3

Course Learning Objectives (CLOs):

CLO_{01} To gain fundamental knowledge of the principles related to, so as to meet the challenging requirements of students in chemistry studies.

CLO_{02} To attain awareness in students about current & new issues in the fields of chemistry.

CLO_{03} To make students understand about the present needs without compromising on theability of future generations to meet their own needs for proper engineering, relevanteducation efficient management of resources.

CLO_{04} To increase curiosity and give them awareness about practical knowledge of variouslaboratory methods among the students regarding the course.

Unit-I Lubricants

Introduction, Classification of lubricants, Mechanism of lubrication, Properties and Testing of lubricating oils (Flash and Fire point, Cloud and Pour point, Viscosity and Viscosity Index, Neutralization number, Saponification Number, Steam Emulsification Number, Aniline Point, Iodine Value), Numerical problems based on testing methods.

Unit -II Polymer

Introduction and Classification of polymer, Preparation, Properties andUses of the following- Polythene, PVC, Teflon, Nylon 66, Bakelite, Silicone resin, Natural and Synthetic Rubber, Vulcanization of Rubber, Biopolymers, Biodegradable polymers.

Unit -III New Engineering Materials

Introduction, PropertiesandApplications of - Superconductors, Optical Fiber, Fullerenes, Graphene, Carbon nanotubes, Nanowires.

Unit -IV Instrumental Techniques in Chemical Analysis

Spectroscopy, Electromagnetic spectrum, Beer &Lambert's Law and its limitations,Principle, Instrumentation and Applications of-UV-VisibleSpectroscopy, IR Spectroscopy, Gas Chromatography.

Unit- V Electrochemistry

Concept of Enthalpy, Entropy and Free energy, EMF, Applications of EMF measurements, Corrosion- Definition, Types, Causes and Protection from corrosion.

Text Books:

1. Preeti Jain, Anjali Soni, Jeetendra Bhawsar, A text book of Engineering Chemistry, 1st edition, Manthan Publication, 2016.
2. Preeti Jain, S L Garg, Engineering Chemisty, 4th edition, Variety Publication.
3. Shashi Chawla, Engineering Chemistry, 11th edition, Dhanpat RaiPublications.

References:

1. P C Jain, Monika Jain, Engineering Chemistry, Dhanpat RaiPublications.
2. S. S.Dara, A Text Book of Engineering Chemistry, S. Chand & Company.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To Understand the lubricants, their mechanism and practically analyze the properties of lubricants.
CO_{02} Will acquire betterment in lifestyle by understanding the need of bio polymers in the current scenario and replacing synthetic polymers with its bio-polymer substitute.
CO_{03} Will get familiarized with new engineering materials and their commercial applications.
CO_{04} Will get knowledge of using instrumental techniques and their applications for determination of chemical structure of any compound.
CO_{05} Identify various types of corrosion and methods to protect the metallic structures from corrosive environment.

List of Practicals:

Volumetric Analysis:

1.To determine Hardness of given water sample by Complexometric titration.
2.To determine total and mixed Alkalinity of given water sample using phenolphthalein and methyl orange as indicator.
3.To determine strength of unknown FAS solution by Redox titration using N-Phenyl anthranilic acid as internal indicator.
4.To determine strength of unknown $CuSO_4$ solution by Iodometric titration using Starch as internal indicator.
5.To determine Chloride content of water sample by Mohr's method (Argentometric titration).

Fuel Testing:

1.Todeterminemoisturecontentingivensampleofcoalbyproximateanalysis.
2.Todeterminevolatilecontentingivensampleofcoalbyproximateanalysis.

3.Todetermineashcontentingivensampleofcoalbyproximateanalysis.

4.To determine percentage carbon content of coal by proximate analysis.

Lubricant Testing:

1. To determine penetration number of grease by Cone Penetrometerapparatus.
2. To determine flash and fire point of given oil sample by Cleveland's open cup apparatus.
3. To determine flash point of given oil sample by Penskey Marten's close cup apparatus.
4. To determine flash point of given oil sample by Abel's Closecup apparatus.
5. To determine Steam emulsification number of givenlubricant.
6. To determine Aniline point of given oilsample.
7. To determine Cloud and Pour point of given lubricatingsample.
8. To study rate of change of viscosity with temperature of the given lubricating oil by meansof Redwood Viscometerno.1
9. To study rate of change of viscosity with temperature of the given lubricating oil by means of Redwood Viscometer no.2.

Electrochemistry:

Variation of cell potential in $Zn/Zn^{2+}//Cu^{2+}/Cu$ with change in concentration of electrolytes ($CuSO_4$ or $ZnSO_4$) at room temperature.

Kinetics:

Effect of concentration and temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid.

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3ES16	Basic Electronics Engineering	3	0	2	4

Course Learning Objectives (CLOs):

CLO01 To learn the basics of semiconductor materials and their usage in variety of PN junction diodes and applications of diodes

CLO02 To study transistor in different modes of configuration and basic biasing techniques, FET.

CLO03 To study of the fundamental concepts and various types of analog communication systems

CLO04 To study of the concept of number systems and Boolean Algebra, minimization, Logic gates and other Combinational circuits and their designing.

CLO05 To learn about basic Measurement & Instrument components.

Unit-I SEMICONDUCTOR DIODE
Semiconductor basics, PN Junction diode construction & working, Volt-amp characteristics, Diode current equation, Half wave rectifier, Full wave rectifier: Bridge and center tapped rectifier,Clipper and Clamper. Zener diode and zener diode-based voltage regulator, LED

Unit-II BIPOLAR JUNCTION TRANSISTOR
Construction and working of transistor, characteristics of transistor, transistor as an amplifier andswitch, transistor configurations, transistor biasing and biasing methods, basic amplifier configurations, Basic principle and working of FET and MOSFET

Unit-III BASICS OF COMMUNICATION SYSTEMS
Block schematic of communication system, Simplex and duplex systems, Modes of communication: Broadcast and point to point communication, Necessity of modulation, Classification of modulation: Amplitude, phase, frequency modulation, sampling theorem and pulse amplitude modulation.

Unit-IV DIGITAL SYSTEM
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Boolean theorems, Minterms and Maxterms, Sum of products and products of sums, Karnaugh map Minimization, Logic gates: NOT, AND, OR, NAND, NOR, EX-OR and EX-NOR, half adder and full adder. Function and Structure of a Computer System, Von Neumann Architecture, and modern computers.

Unit-V ELECTRONICS MEASUREMENT
Introduction, Basics of Measurements, Ammeter, Voltmeter, multimeter, Signal Generators,

Cathode Ray Oscilloscope: Block diagram of CRO, Construction of CRT, Deflection sensitivity and various controls, Measurement of voltage, current frequency and phase angle using CRO

Textbooks:

1. Millman and Halkias: Integrated electronics, TMH.
2. D Roy Choudhury, Digital Electronics, Vol-I & II, TMH Publication.
3. A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai.
4. Simon Haykins, Communication System, John Willy.
5. Andrew S. Tanenbaum, Structured Computer Organization, Upper Saddle River.

References:

1. Sedra and Smith: Microelectronics, Oxford Press.
2. Millman and Taub, Pulse, Digital and Switching Waveforms, MGM.
3. A.Anand Kumar: Digital Circuits, PHI.
4. Salivahanan: Electronic Circuits Analysis and Design, TMH
5. Boylestad and Nashelsky: Electronic Devices and Circuit Theory, Pearson Education.
6. B.P.Lathi, Modern Digital & Analog Communication System, TMH

Course Outcomes (COs):
After completion of this course the students shall be able to:

CO_{01} Should have the knowledge of basic semiconductor materials and their usage in variety of PN junction diodes and applications of diodes

CO_{02} Should be able to understand the concept operation of transistors and its configuration.

CO_{03} Understand and identify the fundamental concepts and various components of analog communication systems

CO_{04} Should have the knowledge of number systems and Boolean Algebra, minimization, Logic gates and other Combinational circuits and their designing.

CO_{05} Should have understood the basics of Measurement & Instrument components.

List of Experiments:

1. To verify V-I characteristic of semiconductor & Zener diode.
2. To verify input and output waveform of half wave rectifier.
3. To verify input and output waveform of full wave rectifier.
4. To verify Input and output characteristic of BJT in CB and CE configurations.
5. Implementation of basic logic gates using Universal gates (NAND, NOR).
6. To verify half adder & full adder.
7. Study of computer system structure and main peripheral devices.
8. Study of Frequency Division Multiplexing with sinusoidal inputs / audio

inputs.

9. Study of CRO and its demonstration kit.
10 Study of voltmeter and multimeter.

Course Code	Course Name	Hours per Week			Total	
		L	T	P	Hours	**Credits**
EN3ES18	**Basic Mechanical Engineering**	**3**	**0**	**2**	**5**	**4**

Course Learning Objectives (CLOs):

CLO01 To understand the properties of materials and their behavior with variation in temperature and Load. To understand different measuring instruments used in engineering applications.

CLO02 To understand the basic laws of thermodynamics and their applications in engineering, refrigeration cycles and properties of refrigerants.

CLO03 To understand Construction and Working of I. C. Engines.

CLO04 To understand Construction and Working of Steam Generators

CLO05 To understand the concepts of Centroid & Moment of Inertia and of plane areas and different theorems of moment of Inertia

Unit-I Materials & their mechanical properties
Classification of Engineering material and their mechanical properties, Composition of cast iron and carbon steels and their application. Stress-strain diagram, Hooks law and modulus of elasticity.Tensile, shear, hardness, and fatigue testing of materials.

Unit-II Thermodynamics
Thermodynamic properties and systems, First of thermodynamics, thermal processes at constant pressure, volume. Second law of thermodynamic, enthalpy, entropy, heat engine, heat pump, refrigerator and their numerical.

Unit-III I.C. Engines
Description and working of four stroke petrol engines, two stroke petrol engines, four stroke diesel engines and two stroke diesel engines, and its efficiency relative merits and demerits.

Unit-IV Steam generators
Definition, Classification, general study of Cochran, Lancashire and Locomotive boilers, boilers mountings and accessories. Steam properties and boiler performance. Draught Classification, Calculation of Chimney height, boiler efficiency and numerical. Unit V: Centroid & Moment of Inertia Location of centroid and Moment of Inertia of plane areas, Perpendicular Axis and Parallel Axis theorems.

Unit V Centroid & Moment of Inertia
Location of centroid and Moment of Inertia of plane areas, Perpendicular Axis and Parallel Axis theorems.

Textbooks:

1. R.K. Rajput, Basic Mechanical Engineering, Laxmi Publication.
2. P.K. Nag, Engineering Thermodynamics, McGraw Hill.
3. R.K. Bansal, Engineering Mechanics, Laxmi publications.

References:

1. Anand K Bewoor, Vinay A Kulkarni, Ist edition, Metrology & Measurement, McGraw Hill.
2. Cengel and Boles, Thermodynamic, An Engineering Approach in S.I Unit, McGraw Hill.
   S.S. Bhavikatti and K.G.Rajashekarappa, Engineering Mechanics, New age international limited.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Students will be able to understand the engineering materials, their properties, Iron-Carbon Diagram and Stress-Strain Curve, Measuring Equipment's and Testing Machines.

CO_{02} Student will be thorough with the basic laws of thermodynamics and their applications in engineering also know about Refrigeration cycles and properties of refrigerants.

CO_{03} Students will be able to understand the construction and working of I.C. Engines .

CO_{04} Students will be able to understand the construction and working of Steam Generators

CO_{05} Students will be able to determine the Centroid & Moment of Inertia of areas/composite sections.

List of Experiments

1. Measurements using Vernier calliper & micrometer.
2. Measurements using dial gauges and combination set.
3. Measurements using slip gauges & sine-bar.
4. Tensile Testing of standard mild steel specimen on UTM.
5. To determine the hardness number by using Brinell Hardness Testing Machine.
6. Study of 2-stroke petrol and diesel engine.
7. Study of 4-stroke petrol and diesel engine.
8. Study of different type of boilers.
9. Study of different type of boilers mounting & accessories.
10. To find the centroid of different plane laminas.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3ES28	Advanced Programming with C	2	0	2	3

Course Learning Objectives (CLOs):

CLO01 Understand Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Accessing arrays, strings through pointers.

CLO02 Declaration and use structures, perform operations on structures, passing structures as function arguments. type defining structures.

CLO03 Use Function declaration, function definition, function call, Passing arguments to a function, by value, by reference. Scope of variable names, creation of header files

CLO04 Use calloc, malloc, realloc dynamic memory.

CLO05 Apply Input-output using files in C, Opening, closing and reading from files. Programming for command line arguments.

CLO06 Apply graphics functions to create pictorial representation and animations

Unit-I Pointers

Introduction to Pointers (Declaration and Initialization), Double Pointer, Pointers and Array, Pointers and Functions, Operations on Pointers.

Unit-II User Defined Data Types

Defining a Structure, Declaration of Structure Variables, Initialization of Structure Variables, Accessing Structure Members, Storage of Structures in Memory Array within a Structure, Array of Structure, Pointer Structure, Passing Structure to a Function, Structure within a Structure. Define Union, Structure versus Union, Working with Union, Initializing Union, Enumerated Data Type.

Unit-III Pre-processor and Memory Allocation

Pre-processor Directives, Macro and Macro Expansions, File Inclusions, Conditional Compilation, Stringification (#) and Token Passing Operator (##), Type Def, Command Line Argument, Dynamic Memory Allocation. malloc(), calloc(), realloc(), free(), Core Dump, Memory Leak, Dynamic 1D and 2D Arrays. Header Files and Their Creations.

Unit-IV File Handling

File Concept, File Pointer and File Handling Operations Using files in C, Buffer and Streams, Working with Text Files and Binary Files, File Operations using std. Library and System Calls, File Management I/O Functions, Random Access Files.

Unit-V Graphics Programming

C Header Files for handling graphics and initializing graphics mode, Understand Coordinate system, Function to Draw Lines,Circle, Arc, Ellipse, pieslice, sector, Rectangle, Bar, 3-D Bars & Polygon, Color Spraying: filling Ellipse, polygons and flooding the fills, Filling Styles and Patterns, Understand Animation, Function to create Animation, Traffic Light and Moving Car Simulation.

Text Books:

1. Herbert Schildt, C: The complete Reference, Fourth Edition, Mc-Graw Hill.
2. R. Sethi, Programming Language Concepts and Constructs, Pearson Education.
3. V. Rajaraman, Computer Programming in 'C', PHI.
4. M. Sprankle, Programming and Problem Solving, Pearson Education.
5. R.G. Dromey, How to solve it by Computer, Pearson Education.
6. E. Balguruswamy, Programming in ANSI C by, Tata Mc-Graw Hill.
7. Yashavant Kanetkar, Let Us C, BPB.
8. E. Balagurusamy, Fundamentals of Computers, TMH.
9. AL Stevens, C Database Development, MIS Press.

References:

1. Kernighan and Ritchie, The 'C' programming language, PHI.
2. Programming With C, Schaum Series.
3. A. N. Kamthane, Programming with ANSI and Turbo C, Pearson Education.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Apply Pointers, Pointer Arithmetic and Accessing arrays, strings through pointers.
CO_{02} Use different user defined data types like structures, union and enum.
CO_{03} Understand and Use of dynamic memory allocation and preprocessor directives.
CO_{04} Use the concepts of file handing.
CO_{05} Use Graphics programming to draw and use different shapes.

List of Practical

1. Program to create, initialize, assign and access a pointer variable.
2. Program to swap two numbers using pointers.
3. Program to change the value of constant integer using pointers.
4. Program to print a string using pointer.
5. Program to count vowels and consonants in a string using pointer.
6. Program to find sum of elements of array using pointer.
7. Program to swap two numbers using pointers.
8. Compare strings using pointer
9. Find smallest number in array using pointer.
10. Find largest element in array using pointer.
11. Find sum of all matrix elements using pointer.
12. Program to create a pointer array store elements in it and display.
13. Program to demonstrate function pointers.
14. Program to perform Addition Subtraction Multiplication Division using array of function pointers.
15. Program to display details of student two (Name, roll no, marks) using structure.
16. Program to display details of employee using array of structure.
17. Program to access member of structures using pointers.
18. Program for passing structure to a function.
19. Program for returning a structure from a function.
20. Program to display details of student two (Name, roll no, marks) with the help of union.
21. Program to demonstrate the memory allocation in structure and union.
22. Program to demonstrate malloc and calloc.
23. Program to allocate memory of array at run time.
24. Program to print the day of week.
25. Program to print month of a year.
26. Program to calculate area of circle using macro.
27. Program to calculate area of circle using macro function.
28. Program to create a header file and use it in a program.
29. Program to demonstrate file operation.

a. Creating a new file
b. Opening an existing file
c. Closing a file
d. Reading from and writing information to a file

30. Program to count number of words, number of character and number of lines from a given text file.
31. Program in C to delete a specific line from a file.
32. Write a program in C to append multiple lines at the end of a text file.

33. Write a program in C to copy a file in another name.
34. Write a program in C to merge two files and write it in a new file.
35. Write a program in C to encrypt a text file.
36. Write a program in C to decrypt a previously encrypted file.
37. Write a program in C to remove a file from the disk.
38. Write a program to draw a circle and fill blue color in it.
39. Write a program to draw a rectangle with diagonal and fill different colors in both halves.
40. Write a program to move a circle using suitable annimations.
41. Write a program to implement traffic signal.
42. Write a pogram to simulate a moving car. Draw car using simple shapes like line, circle and polygon.

Course Code	Course Name	Total Hours per week			Total	
		L	T	P	Hours	Credits
EN3ES29	**Engineering Workshop**	**0**	**0**	**2**	**2**	**1**

Course Learning Objectives (CLOs):

CLO01 To familiar with Lathe, Drilling, Milling and shaping machines.

CLO02 The basic law of physics and their utilization in engineering.

CLO03 To understand different primary manufacturing process.

CLO04 To understand different metal joining process.

CLO05 To identify different tools used in basic manufacturing process.

Unit-I Introduction and Demonstration: - Introduction to various shops / sections and workshop layouts. Safety norms to be followed in a workshop.
Carpentry Shop: Introduction of Tools & operations, Types of woods & their applications, Types of Carpentry tools and their uses, Carpentry Joints, carpentry operations such as marking, sawing, planning, chiseling, grooving, boring, joining, types of woods and carpentry hardware.

Unit-II Fitting Shop: Introduction of Tools & operations, Types of Marking tools & their uses, Types of fitting cutting tool & their uses, fitting operations such as chipping, filing, scraping, grinding, sawing, marking, drilling, tapping

Unit-III Foundry Shop: Pattern Making: Study of Pattern materials, pattern allowances and types of patterns. Core box and core print. Use and care of tools used for making wooden patterns.
Molding: Properties of good mould & Core sand, Composition of Green, Dry and Loam sand. Methods used to prepare simple green sand mould using single piece and split patterns.
Black Smithy Shop: Use of various smithy tools. Forging operations: Upsetting, drawing down, Fullering Swaging and Cutting down.

Unit-IV: Welding Shop: Study and use of tools used for Brazing, Soldering, Gas & Arc welding. Preparing Lap & Butt joints using gas and arc welding methods, Study of TIG & MIG welding processes. Safety precautions.

Unit V: Machine Shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools). Demonstration of different operations on Lathe

machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling, and parting. Demonstration and applications of drilling machine, Demonstration of CNC Machines

Textbooks:

1. B.S. Raghuwanshi, Workshop Technology Vol. I & II, Dhanpath Rai & Sons.
2. R.S. Khurmi, Workshop Technology, S. Chand and Co.
3. S.K. Hajra Choudhary, A.K. Hajra Choudhary and Nirjhar Roy, Elements of Workshop Technology, vol. I Media promoters and Publishers Pvt. Ltd
4. R.K. Bansal, Engineering Mechanics, Laxmi publications.

References:

1. W. A.J. Chapman, Workshop Technology, 1998, Part -1, 1st South Asian Edition, Viva Book Pvt. Ltd.
2. P.N. Rao, 2009, Manufacturing Technology, Vol.1, 3rd Ed., Tata McGraw Hill Publishing Company.
3. Dr. S.K. Sinha , CNC programming — Golgotia publication.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Understand the engineering materials, their properties, and their utilization in manufacturing tool and other equipment's.

CO_{02} Understand the primary manufacturing process.

CO_{03} Understand the basic operation involve in casting.

CO_{04} Understand the basic process of forging.

CO_{05} Basic knowledge of simple cutting, holding. Marking and striking tool.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3NG02	Universal Human Values and Professional Ethics	2	0	0	2

Course Learning Objectives (CLOs):

CLO_{01} Student will able to understand about the process of value education.
CLO_{02} Student will able to understand harmony in human being.
CLO_{03} Student will able to understand Harmony in the Family and Society
CLO_{04} Student will able to understand Harmony in the Nature and Existence
CLO_{05} Student will able to understand Holistic Understanding of Harmony

Unit-1

Introduction-Need, Basic Guidelines, Content and Process for Value Education

Understanding the need, basic guidelines, content and process for Value Education, Self-Exploration – what is it ?-its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self - exploration, Continuous Happiness and Prosperity-A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities-the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Unit-2

Understanding Harmony in the Human Being-Harmony in Myself

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body'- Sukhand Suvidha, Understanding the Body as an instrument of 'I'(I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyamand Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

Unit-3

Understanding Harmony in the Family and Society-Harmony in Human- Human Relationship

Understanding harmony in the Family- the basic unit of human interaction, Understanding values in human -human relationship ;meaning of Nyayaand program for its fulfilment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship, Understanding them eaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman ,Difference between respect and differentiation ;the other salient value in relationship, Understanding the harmony in the society(society being an extension of family):Samadhan, Samridhi, Abhay, Sah-astitvaas comprehensive Human Goals, Visualizing a universal harmonious order in society-

Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)-from family to world family!.

Unit-4

Understanding Harmony in the Nature and Existence-Whole existence as Co-existence

Understanding the harmony in the Nature, Inter connectedness and mutual fulfilment among the four orders of nature –recyclability and self-regulation in nature, Understanding Existence as Co-existence(Sah-astitva) of mutually interacting units in all-pervasive space, Holistic perception of harmony at all levels of existence.

Unit-5

Implications of the above Holistic Understanding of Harmony on Professional Ethics

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics:

a) Ability to utilize the professional competence for augmenting universal human order,
b) Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, technologies and management models, Case studies of typical holistictechnologies,managementmodelsandproductionsystems,Strategyfor transition from the present state to Universal Human Order:
a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers,
b) At the level of society :as mutually enriching institutions and organizations.

TextBooks:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

References:

1. IvanIllich,1974,Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F.Schumacher,1973, Smallis Beautiful: a sudy of economics as if people mattered, Blond & Briggs, Britain.
3. SussanGeorge,1976,HowtheOtherHalfDies,PenguinPress.Reprinted 1986, 1991
4. Donella H .Meadows, DennisL. Meadows,JorgenRanders, WilliamW. BehrensIII, 1972, Limits to Growth–Club of Rome's report, UniverseBooks.
5. ANagraj, 1998, JeevanVidyaEkParichay, DivyaPathSansthan, Amarkantak.
6. PLDhar, RRGaur,1990,Science and Humanism,Commonwealth Publishers.

7. A NTripathy, 2003, Human Values, New Age International Publishers. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) KrishiTantraShodh, Amravati.
8. EGSeebauer&RobertL.Berry,2000,FundamentalsofEthicsforScientists&Engineers , Oxford University Press
9. MGovindrajran,SNatrajan&V.S.SenthilKumar,EngineeringEthics(including HumanValues),EasternEconomyEdition,PrenticeHallofIndia Ltd.
10. BP Banerjee,2005, Foundations of Ethics andManagement, Excel Books. BLBajpai,2004,IndianEthosandModernManagement,NewRoyal Book Co., Lucknow. Reprinted 2008.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Students get knowledge about the process of value education.

CO_{02} Understand human being as a co-existence

CO_{03} Understanding values in human -human relationship

CO_{04} Understanding Existence as Co-existence(Sah-astitva) of mutually interacting units in all-pervasive space

CO_{05} Understanding Natural acceptance of human values

Course Code	Course Name	Hours per Week			
		L	T	P	Credits
EN3HS10	COMMUNICATION SKILLS	2	0	2	3

Course Learning Objectives (CLOs):

CLO_{01} To develop, enhance and demonstrate LSRW Skills.

CLO_{02} To enable students to acquire oral presentation skills.

CLO_{03} To prepare students to become more confident and active participants in all aspects of their undergraduate programs

CLO_{04} To enable students with good vocabulary, grammar and writing skills.

CLO5 To enable students to distinguish between general and technical communication and understand its importance

Unit-I

Grammar and Vocabulary Development : Applied Grammar and usage: Parts of Speech, Tenses, Subject-Verb Agreement, Active and Passive Voice, Clauses, Modals, Reported Speech, common errors. Vocabulary: Synonyms, Antonyms, Homophones, One Word Substitution, Affixation: Prefixes & Suffixes, Correctly Spelt Words, Idioms, Proverbs, and Derivation from root words.

Unit-II

Developing Effective Communication Skills: Corporate Communication, Process, Characteristics and principles, Verbal and non-verbal communication, Barriers to effective communication, Importance of effective communication, Importance of Feedback in communication. Seven Communication.

Unit-III

Speaking Skills and Oral Presentation: Preparing for and conducting presentations, Introducing yourself, Use of formal expressions, Delivery using Audio – Visual Aids with stress on body language and voice modulations, audience research, objective of presentation, Assimilation of data and post presentation strategy.

Unit-IV

Developing Reading and Listening Skills: Reading Comprehension, Process, note-making, note - taking, SQ3R reading technique. Listening Skills: Meaning, process hearing and listening, types, barriers.

Unit-V

Developing Writing Skills: Précis, Paragraph writing, digital communication etiquettes. Business Letters: Parts & Layouts of Business Letters, writing job application and Resume, Calling/ Sending Quotations/ Orders/ Complaints and E-mails.

Text Books:

1. P.C. Wren and Martin, High School English Grammar & Composition, , S Chand and Co Pvt Ltd.
2. S. Kumar and P. Lata , English for Effective Communication, Oxford UP, New Delhi.
3. J.S. Korlahalli and R. Pal, Essentials of Business Communication All Courses, Sultan Chand & Sons.

References Books

1. A.C. Gimson, An introduction to the Pronunciation of English, ELBS.
2. S. Greenbaum, The Oxford English Grammar, Oxford University Press.
3. K.Mohan and M. Raman, Effective English Communication, Tata Mc-Graw Hill.
4. A.J. Thompson and A. V. Martinet, A Practical English Grammar, Oxford UP, New Delhi.
5. U. S. Rai and S.M, Rai, Effective Communication, Himalaya Publishing House.

List of Practicals (Wherever Applicable)

1. Exercises on Grammar and vocabulary
2. Exercises based on reading and comprehension which also include taking notes during presentation.
3. Exercises based on listening which also include taking notes.
4. Writing technical description precis, business letters.
5. Presentations on various issues.
6. Presentations with Non verbal communication.
7. Delivering speeches and exercising voice modulation transcription.
8. Performing extempore.
9. Role plays.
10. Group discussions.

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Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} The students will be able to enhance confidence in their ability to read, comprehend, organize, and retain written and oral information.

CO_{02} The students will be able to distinguish between general and technical communication and understand its importance

CO_{03} The students will be able to improve upon their language skills, communication skills, group discussion, and personality development and confidence level.

CO_{04} The students will be able to bridge the language gap which is vital to their success

CO_{05} Students will be able to communicate effectively.

SEMESTER – III

Sr. No.	Course Code	Course Name	L	T	P	Credits
1	EN3BS15	Engineering Mathematics-III	3	0	0	3
2	RA3CO23	Strength of Materials for Mechanical Engineers	3	0	2	4
3	RA3CO24	Kinematics and Dynamics of Machines	3	0	2	4
4	RA3CO25	Basic of Thermal Engineering	3	0	2	4
5	RA3CO51	Digital Electronics	3	0	2	4
6	RA3CO27	Sensors and Instrumentation	3	0	0	3
9	RA3CO40	CAD Lab	0	0	2	1
10	EN3NG09	Soft Skills-I	2	0	0	2
		Total	**20**	**0**	**10**	**25**
		Total Contact Hours	**30**			

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
EN3BS03	Engineering Mathematics-III	3	0	0	3

CLO_{01} Understand the concepts and methods of different operators and interpolation techniques, including Newton Forward and Backward Formulae.

CLO_{02} Apply numerical integration techniques such as Simpson's, Weddle's, and Trapezoidal rules to solve practical problems.

CLO_{03} Analyse discrete and continuous probability distributions, including Binomial, Poisson, Normal, and Exponential distributions.

CLO_{04} Evaluate the effectiveness of different curve fitting and regression techniques, including the Method of Least Squares and correlation coefficients.

CLO_{05} Create a detailed analysis of hypothesis testing methods, including Chi-Square, t-tests, and Z-tests, applying them to real-world data.

Unit I: Numerical Interpolation techniques:

Difference Operators, Interpolation (Newton Forward and Backward Formulae), Central Interpolation Formulae (Gauss, Bessel's and Sterling's formula), Lagrange's and Divided Difference formulae, Numerical Differentiation.

UnitII: Numerical Differentiation and integration:

Numerical Integration (Simpson's, Weddle's, Trapezoidal rules), Numerical Solution of Ordinary Differential Equations (Taylor's Series, Picard's, Euler's Modified, Runge-Kutta, Milne's Predictor and Corrector methods)

Unit III: Probability Distribution:

Discrete Distribution: Binomial, Poisson Distribution with mean variance, Moment generating function.

Continuous Distribution: Normal and Exponential Distribution with mean variance, moment generating function.

Unit IV: Curve fitting, Correlation, Regression:

Curve fitting (Method of Least Square), linear and nonlinear curves, Correlation, Karl Pearson's Coefficient of Correlation, Spearman's Rank Correlation Coefficient, Linear Regression, Regression coefficients, Properties of regression curve.

Unit V: Testing of Hypothesis:

Introduction to testing of hypothesis, Statistical assumptions, Level of significance, Confidence level, Type I Error, Type II error, Critical value, Power of the test, sampling distribution, Chi-Square test, small sample test – t test for one and two sample mean, F test, Large Sample test ,Z test for equality of single mean, equality of two sample.

Text Books

1. Higher Engineering Mathematics, B.V. Ramana, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.
2. Probability and Statistics, Ravichandran, Wiley India.

Reference Books

1. Sheldon M. Ross, "Introduction to Probability Models", Elsevier Publication, Academic Press, UK
2. Numerical Methods for Scientific and Engineering Computation, M .K. Jain, Iyengar and R. K. Jain, New Age International Publication.

CO_{01} Understand the principles of numerical interpolation techniques and their applications, including Newton Forward and Backward Formulae.

CO_{02} Apply numerical methods for integration and differentiation, including Simpson's and Trapezoidal rules, to solve ordinary differential equations.

CO_{03} Analyse the characteristics and applications of various probability distributions, such as Binomial, Poisson, Normal, and Exponential.

CO_{04} Evaluate the suitability and accuracy of different curve fitting and regression methods, including linear and nonlinear models.

CO_{05} Create and **interpret** hypothesis tests using various statistical methods, including Chi-Square tests, t-tests, and Z-tests, to evaluate real-world data.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
RA3CO23	Strength of Materials For Mechanical Engineers	3	0	2	4

Course Learning Objectives (CLO's):

CLO_{01} Understand the basic concepts and principles of strength of materials, including key definitions and theorems.

CLO_{02} Analyse how different materials behave under various types of loads, such as axial, torsional, and bending forces.

CLO_{03} Apply knowledge of stress-strain relationships and material properties to determine how materials will respond under different loading conditions.

CLO_{04} Evaluate the mechanical properties of materials and their failure mechanisms to understand the limits and performance of different materials.

CLO_{05} Create solutions for problems involving axial, torsional, and bending loads using principles of strength of materials.

UNIT I: STRESS, STRAIN AND DEFORMATION OF SOLIDS

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains –Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II: TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM

Beams: types transverse loading on beams – Shear force and bending moment in beams Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending, bending stress distribution – Load carrying capacity – Proportioning of sections – Fletched beams – Shear stress distribution.

UNIT III- TORSION

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV- DEFLECTION OF BEAMS

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V- THIN CYLINDERS, SPHERES AND THICK CYLINDERS

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009

REFERENCE BOOKS:

1.Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
2. Ferdinand P. Been, Russell Johnson, J.r.and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
4. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

List of Practicals:

1 Tension test
2 Deflection test on Cantilever beam
3 Deflection test on simply supported beam
4 Torsion test
5 Spring test
6 Izod Impact test
7 Shear test
8 Tensile test on composite materials using UTM
9 Flexural strength of a beam 55
10 Fatigue Testing machine 60

Course Outcomes (CO's):

After completion of course, student will be able to:

CO_{01}: Demonstrate an understanding of the fundamental concepts and principles of strength of materials.
CO_{02}: Analyze the behavior of materials subjected to various types of loads, including axial, torsional, and bending loads.
CO_{03}: Evaluate stress-strain relationships and determine material properties.
CO_{04}: Identify and explain the mechanical properties and failure mechanisms of different materials.
CO_{05}: Solve engineering problems involving the analysis of stress, strain, and deformation in mechanical components.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO24	Kinematics & Dynamics of Machine	3	0	2	4

Course Learning Objectives (CLO's):

CLO_{01}: To Understand the fundamental principles of kinematics and dynamics of machines.
CLO_{02}: To Identify different types of mechanisms and machines and their applications.
CLO_{03}: To analyze the motion of mechanisms, including velocity and acceleration.
CLO_{04}: To Understand the forces acting on mechanisms and how to analyze them.
CLO_{05}: To Design linkages and mechanisms to achieve desired motion and performance.

Unit1: Introduction of Mechanisms and Machines

Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom, Mobility and range of movement – Kutzbachand Grubler's criterion, Number Synthesis, Grashof's criterion, straight line mechanisms

Unit II: Graphical and Analytical Linkage Synthesis

Synthesis, Function, Path, and Motion Generation, Dimensional synthesis (Graphical): Two position synthesis, Three Position synthesis, Coupler curves, Position Analysis : Graphical position analysis of linkages, Algebraic position analysis of linkages, Four bar slider crank position solution, Two position motion generated by analytical synthesis, Three position motion generated by analytical synthesis.

Unit III Velocity and Acceleration Analysis

Graphical and analytical velocity analysis of fourbar pin jointed linkages and fourbar slider crank linkages, Instant centers of velocity, Graphical and analytical acceleration analysis of fourbar pin jointed linkages and fourbar slider crank linkages, Graphical velocity and acceleration analysis of quick return mechanisms

Unit IV: Cams

Types of cams, Types of followers, Follower displacement programming, Derivatives of follower Motion, Motions of follower, Layout of cam profiles supports, vibration Isolation, vibration absorption, torsional vibration of shafts, single and multirotor systems, geared shafts, critical speed of shafts.

Unit V: Friction, Clutch and Brake

Introduction to friction, Law of friction, Coefficient of friction, Inclined plane, Pivot and Collars, Friction clutches, Rolling Friction, Types of brakes, Block and Shoe brakes, Differential band brake, Internal expanding shoe brake, Braking effect in vehicle.

Text books:

1. "Theory of Machines and Mechanisms" by John J. Uicker Jr., Gordon R. Pennock, and Joseph E. Shigley
2. "Kinematics and Dynamics of Machinery" by Charles E. Wilson and J. Peter Sadler
3. "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines" by Robert L. Norton

Reference Books:

1. "Engineering Mechanics: Dynamics" by J.L. Meriam and L.G. Kraige
2. "Machine Design: An Integrated Approach" by Robert L. Norton
3. "Dynamics of Machinery" by Hans Dresig and Franz Holzweißig

Course Outcomes (CO's):

After completion of course, student will be able to:

CO_{01}: Analyze the motion of various mechanisms and machines, including velocity and acceleration
CO_{02}: Apply force analysis techniques to determine the forces acting on machine components.
CO_{03}: Use computational tools and software to simulate the kinematics and dynamics of mechanisms.
CO_{04}: Solve real-world engineering problems involving the kinematics and dynamics of machines.
CO_{05}: Design linkages and mechanisms to meet specific motion and force requirements.

List of Experiments:

1. Drawing work related to inversion of four bar mechanism and slider and crank mechanism.
2. Drawing work related to velocity and acceleration diagram of various mechanisms.
3. Drawing work related to cam profile.
4. Drawing work and computation related to synthesis.
5. Computerized Synthesis.
6. Analysis related to cam.
7. Analysis related to brakes, and clutches.
8. Analysis related to friction.

Course Code	Course Name	Hours Per Week	Total		Total	
		L	T	P	Hrs.	Credits
RA3CO25	Basics of Thermal Engineering	3	0	2	5	4

Course Learning Objectives (CLO's):

CLO_{01}: To understand the fundamental principles of thermodynamics and their applications in engineering.

CLO_{02}: To Explain the different laws of thermodynamics and their applications.

CLO_{03}: To Analyze various thermodynamic cycles such as Carnot, Rankine, and Brayton cycles.

CLO_{04}: To understand Properties of Pure Substances: Study the properties of pure substances and their phase-change processes.

CLO_{05}: Analyze Energy Systems: Apply thermodynamic principles to the analysis of energy systems, including engines and refrigeration systems.

UNIT I

Introduction: Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept Of Continuum, Thermodynamic Equilibrium, State Property. Process, Cycle, Reversibility Quasi static process, Irreversible process Work and Heat, Point and Path function.

UNIT II

Zeroth Law of Thermodynamics, Concept Of quality Of Temperature, Principles of Thermometry, Reference points, Const. Volume gas Thermometer, Scales of Temperature, Ideal Gas Scale, MM I,- Joule's Experiments.

First law Of Thermodynamics, Corollaries, First law applied to a process, applied to a flow system, Steady Flow Energy Equation, Limitations of the First Law.

Second Law Of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle Of Entropy Increase, Energy equation, Availability and Irreversibility, Elementary Treatment of the Third Law of Thermodynamics.

UNIT III

Power Cycles: Otto, Diesel, Dual Combustion cycles, Description and representation on P-V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air Standard basis, comparison with Ideal and Actual Cycles.

Joule and Rankine cycles: Description and representation on P-V and T-S diagram, Thermal Efficiency - performance, Evaluation combined cycles.

Refrigeration Cycles: Brayton and Rankine cycles, performance Evaluation, combine cycles, Bell- Coleman cycle, Vapor compression cycle-performance Evaluation.

UNIT IV

I.C. Engines: Classification, Two & Four Stroke Engines, Working principles, Valve and Port Timing Diagrams, Engine systems.

Fuel system: Fuels used, Modes of fuel Admission to engine cylinder, Induction and injection, chemically correct fuel- air ratios, Fuel carburetor, Fuel Injection System, Ignition, Cooling and Lubrication.

S.I. Engines: Mixture requirements, Simple carburetor, Limitations, need of auxiliary systems and their working, problems faced in S.I Engine operation.

C.I. Engines: Four stages or combustion, Delay period and its importance, Effect Of engine variables, Diesel Knock, Fuel pump and Injector, Types of Fuel injection systems and their working, Nozzles, Introduction of cooling, Lubrication and super charging systems.

UNIT V

Gas Turbine: Introduction, thermodynamic cycles, schematic Layout, open, closed and semi closed cycles, Parameters of performance and methods of improving performance, Inter cooling Reheating and Regeneration, applications of Gas turbines.

TEXT BOOKS:

1. Rajput, Thermal Engineering, Lakshmi Publications.
2. R.S. Khurmi, J.S.Gupta, Thermal Engineering, S.Chand Pub.

REFERENCE BOOKS:

1. G.VanWyla, RE. Sonntag, Fundamentals of Classical Thermodynamics, John Wiley

2. Jones & Dugan, Engineering Thermodynamics –
3. YunusCongel& Boles, Thermodynamics - An Engineering Approach, TMH
4. J .P.HoIman, Thermodynamics, McGrath
5. YVC Rao, An introduction to Thermodynamics, New Age Pub.

Course Outcomes (CO's):

After completion of course, student will be able to:

CO_{01}: Apply the first and second laws of thermodynamics to analyze energy systems and processes.

CO_{02}: Evaluate the performance of basic thermodynamic cycles, including Carnot, Rankine, and Otto cycles.

CO_{03}: Determine the thermodynamic properties of pure substances and ideal gases using tables and charts

CO_{04}: Apply thermal engineering concepts to solve practical engineering problems and design basic thermal systems.

CO_{05}: Analyze the performance and efficiency of different energy conversion systems, such as engines and gas turbines.

List of Experiments:

1. I.C. Engines Performance Test of 4 -S single cylinder Diesel Engine
2. Heat Balance test on 4-S single cylinder Diesel Engine
3. I.C. Engines Performance Test of 4 -S double cylinder Diesel Engine
4. I.C. Engines - Determination of A/F Ratio and Volumetric Efficiency
5. Performance Test on Variable Compression Ratio Engines.
6. I C Engine Morse and retardation Test
7. Performance Test on Reciprocating Air Compressor
8. Study of I.C. Engines Valve / Port Timing Diagrams
9. Dis-Assembly and Assembly of a automobile vehicle
10. Study of Boiler Models.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
RA3CO51	Digital Electronics	3	0	2	4

Course Learning Objectives (CLO's):

CLO_{01}: To Understand the fundamental principles of digital logic and its applications.

CLO_{02}: To Learn the basics of Boolean algebra and its application in digital circuit design.

CLO_{03}: To Study different types of logic gates and their functions.

CLO_{04}: To Analyze and design combinational circuits.

CLO_{05}: To Understand and design sequential circuits, including flip-flops, counters, and registers.

Unit I: Basic Concepts, Boolean algebra, Theorems and Functions

Number Systems: Decimal number system, binary number system, octal number system, hexadecimal number system, BCD number system, Excess-3 code, Gray code, Alpha numeric code, error detecting and error correcting codes. Arithmetic: Arithmetic number representation, Binary arithmetic, Hexadecimal arithmetic, BCD arithmetic. Boolean algebra and Theorems: Logic gates and logic operations, Boolean theorems and postulates, SOP's & POS's, Minterms and Maxterms. Minimization of Boolean Functions: Algebraic simplification, Karnaugh map simplification, Quine-Mc Cluskey or Tabulation method.

Unit II: Logic Gates

Logic Families: Metal Oxide Semiconductor logic families- switching properties of NMOS and PMOS transistors, static NMOS, dynamic NMOS, Static CMOS and dynamic CMOS logic families, CMOS Transmission gate circuits, Bipolar logic families- switching properties of NPN and PNP transistors, TTL, Schottkey TTL, Comparison of MOS logic circuits(CMOS) with that of a TTL digital circuit, Tristate gates. Electrical characteristics: Meanings of speed, propagation delay, operating frequency, and power dissipated per gate, supply voltage levels, operational voltage levels of various logic families.

Unit III: Combinational Systems

Binary arithmetic units (Adder, Subtractor, n-bit parallel adder & Subtractor, look ahead carry generator), decoder, encoder, multiplexer, Demultiplexer, code converters, Magnitude comparators, parity generators. Implementation of combinational logic by standard IC's.

Unit IV: Sequential Systems

Flip-flop and Latch: SR latch, JK flip-flop, T flip-flop, D flip-flop and latch, Master-slave RS flip-flop, Master-slave JK flip-flop, asynchronous inputs. Registers & Counters: Shift registers (SISO, SIPO, PISO, PIPO), universal shift register. Counters Asynchronous/Ripple counters, Synchronous counters, Modulus-n Counter, Ring counter, Johnson counter, Up-Down counter, asynchronous clear, preset and load in a counter, synchronous clear, preset and load in a counter, typical IC's for counters. Synchronous (Clocked) sequential circuits: Moore and Mealey state machine circuits, Analysis & design of synchronous sequential circuits – State machine design with SM charts.

Unit V: Memory and Programmable Logic

RAM, memory decoding, ROM, PROMs, PAL & PLA, Sequential Programmable Devices (discuss three major devices without going into their detailed construction).

Text Books:

1. Morris Mano M, Michael D. Ciletti, "Digital Design", Pearson Education, 4th Edition, 2007.
2. Charles H Roth (Jr), Larry L. Kinney, "Fundamentals of Logic Design", Cengage Learning India Edition, 5th Edition, 2010.
3. Floyd and Jain, "Digital Fundamentals", Pearson Education, 8th Edition, 2007.

Reference Books:

1. Ronald J. Tocci, "Digital Systems: Principles and Applications", Pearson Education, 10th Edition, 2009.
2. Donald P Leach, Albert Paul Malvino, Goutam Saha, "Digital Principles and Applications", Tata McGraw Hill, 6th Edition, 2008.

Course Outcomes (CO's):

After completion of course, student will be able to:

CO_{01}: Apply the principles of Boolean algebra to simplify and analyze digital logic circuits.

CO_{02}: Design and implement basic logic gates and understand their operations.

CO_{03}: Design and analyze combinational circuits, such as adders, multiplexers, and decoders.

CO_{04}: Understand and design sequential circuits, including various types of flip-flops, counters, and shift registers.

CO_{05}: Identify and use different types of memory devices in digital circuit design.

List of Experiments:

1. Verification of truth table of Logic gates.
2. Implementation of various Logic gates using only NAND gates.
3. Implementation of various Logic gates using only NOR gate.
4. Verification of function of Half/Full adder circuits.
5. Verification of function of Half/full subtractor circuits.
6. Verification of function of Binary to Grey code conversion.
7. Verification of function of Grey to Binary code conversion.
8. Verification of function of 2 line to 4-line decoder.
9. Verification of function of 4 line to 2-line encoder.
10. Verification of function of 4 to 1 multiplexer.
11. Verification of function of 1 to 4 demultiplexer.
12. Study of Parity Generator.
13. Verification of function of Latch and flip-flop.
14. Verification of shift left/ right register.
15. Verification of counter circuit like binary up/down counter, decimal counter, ring counter, Johnson counter etc.
16. Verification of Sequential circuits other than counter and shift registers.
17. Verification of Specification and Performance indices of D/A and A/D converters
18. To study standard graphics symbols for digital logic.
19. To study the construction, working and application of any one memory IC from datasheet.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
RA3CO27	Sensors and Instrumentation	3	0	0	3

Course Learning Objectives (CLO's):

CLO_{01}: To understand the fundamental principles of sensors and instrumentation systems.

CLO_{02}: To Learn about different types of sensors and their applications in various fields.

CLO_{03}: Study the principles of transduction and how sensors convert physical phenomena into electrical signals.

CLO_{04}: Understand the importance of signal conditioning and how to design circuits to process sensor signals.

CLO_{05}: Learn about data acquisition systems and how to interface sensors with these systems

UNIT I: INTRODUCTION

General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data.

UNIT II: TEMPERATURE MEASUREMENT

Thermocouples, Resistance Temperature detectors: 2-wire, 3-wire systems, Thermistors, Radiation and optical pyrometers, Infrared pyrometers, Calibration of temperature sensors.

UNIT III: PRESSURE MEASUREMENTS

Electric pressure transducers: LVDT, strain gauge, Capacitive pressure transducers, Piezo electric pressure transducers, Potentiometric pressure transducer, Low-pressure measurement: McLeod gauge, Thermal conductivity: Thermocouple type, Differential pressure transmitters, Calibration of pressure gauge: Dead weight tester.

UNIT IV: FLOW MEASUREMENTS

Orifice, Venturi, Flow nozzles and pitot tubes, Rotameters, Vortex flowmeters, Electromagnetic flowmeters, Ultrasonic flow meter, thermal flow meter, Mass flow type meters, Shunt flow meters.

LEVEL MEASUREMENTS: Float gauge, Bubbler (Purge) system, Hydrostatic pressure type in open vessels and closed vessels, Differential pressure method, Electrical conductivity method, Capacitance type, Radioactive type, Ultrasonic type.

UNIT V RECORDER

Operating mechanism, Chart drive mechanism, Strip chart recorders, Circular chart recorders, X-Y type recorders, Magnetic tape recorders.

Text Books:

1. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons
2. R. K. Jain, Engineering Metrology, Khanna Publishers, New Delhi.
3. R.K. Rajput, Mechanical Measurement and Instrumentation, Katson Books.
4. C. Sujatha, Vibration and Acoustics, Tata McGraw Hill.

Reference Books

1. I.C. Gupta, Engineering Metrology, Danpat Rai Publications.
2. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill.
3. B. C. Nakra, K. K. Chaudhry, Instrumentation, Measurement And Analysis, Tata McGraw Hill.
4. Robert J. Hocken, Paulo H. Pereira, Coordinate Measuring Machines and Systems, CRC Press.

Course Outcomes (CO's):

By the end of this course, students will be able to:

CO_{01}: Explain the fundamental principles of operation for various types of sensors.

CO_{02}: Identify and select appropriate sensors for specific applications based on their characteristics and requirements.

CO_{03}: Apply principles of transduction to convert physical phenomena into measurable electrical signals.

CO_{04}: Design and implement signal conditioning circuits to process sensor outputs effectively.

CO_{05}: Integrate sensors with data acquisition systems and perform data collection and analysis.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
RA3CO40	CAD Lab	0	0	2	1

Course Learning Objectives (CLOs):

CLO_{01}: To understand the AutoCAD workspace and user interface

CLO_{02}: To understand the use of basic drawing command and editing command

CLO_{03}: To understand the difference between 2D Drafting, Isometric drafting and 3D modeling

CLO_{04}: To get familiar with use of tools used to make 2D Drafting, Isometric Drafting

CLO_{05}: To get familiar with use of tools used to make 3D Geometry

Part-A: Introduction to Machine Drawing

- Conventional representation of Machine Components
- Sectional views of Machine Components
- Dimensioning of Machine Components
- Surface finish, GD & T symbols

Part-B: Application of Computer Aided Drafting

- Getting familiar with Drafting
- Draw Toolbar
- Hatching & Gradient
- Modify Toolbar, Array Tool
- Status Bar toggle keys
- Object Properties, Important drawing Tools
- Dimension Toolbar
- Isometric Drafting
- Creating Multileader, Geometric Drawing & Tolerances, Text, Table
- Blocks & Groups
- Managing Drawing with layers
- Parametric Drawing
- External References, Layout Printing & Plotting

Part-C: Introduction to the 3D Modeling Workspace

- Basic 3D Viewing Tools
- 3D Navigation Tools

- Introduction to the User Coordinate System (UCS)
- Working with Solid Primitives, Solid Primitive Types
- Working with the User Coordinate System
- Complex 3D Geometry
- Extruded Solids and Surfaces
- Swept Solids and Surfaces
- Revolved Solids and Surfaces, Lofted Solids and Surfaces, NURBS Surfaces
- 3D Gizmo Tools, Aligning Objects in 3D Space
- 3D Modify Commands, Editing Components of Solids, Editing Faces of Solids
- Fillets and Chamfers, Creating a Shell
- Imprinting Edges of Solids, Slicing a Solid along a Plane
- Converting Objects to Surfaces, Converting Objects to Solids,

Part-D: Refining the View

- Working with Sections, Working with Cameras, Managing Views in 3D
- Creating Visual Styles, Working with Materials Specifying Light Sources
- Rendering Concepts, Working Drawings from 3D Models
- Creating Multiple Viewports, 2D Views from 3D Solids.

Part-E: Drawing Practice: 2D & 3D

Individual Projects:

1. Shift Lever
2. Form Roll Leaver
3. Nut, bolt & washer assembly
4. Knuckle Joint Assembly
5. Cotter Joint
6. Universal Joint
7. Solid muff coupling
8. Bush Type Coupling
9. Crosshead
10. Cam shaft
11. Connecting rod
12. Piston
13. Piston and connecting rod

14. Plumber block
15. Bush Bearing
16. Journal Bearing

Text Books:

1. AutoCAD 2021 For Beginners. By Cadfolks, Kishore Publication
2. A Hand Book On Autocad Tools Practice by Azhar Wahab, Notion Press publication
3. Mastering AutoCAD 2019 and AutoCAD LT 2019 By Brian C. Benton and George Omura, Sybex publication
4. Discovering AutoCAD 2020 By Mark Dix, Macromedia Press
5. Autocad Mechanical Exercise Book, by CAD Desk, CAD Desk Publication

Reference Books:

1. AutoCAD 2020 A Project-Based Tutorial By Tutorial books, Independently published
2. AutoCAD Exercises for Beginners: Designers WorkBook for Practice ByShameer S.A., Independently Published
3. Beginning AutoCAD 2022 Exercise Workbook, by Cheryl R. Shrock, Steve Heather, Industrial Press
4. 3D Modelling Mechanical Exercise Book, by CAD Desk, CAD Desk Publication

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01}: Understand CAD, its Importance and Application

CO_{02}: Understand the workspace and user interface of CAD Software

CO_{03}: Understand the application of different Drawing Command Editing Command for 2D Drafting, Isometric Drafting and 3D modeling

CO_{04}: Analyze Industrial Drawing of Various product

CO_{05}: Create solid 3D model using any CAD software

SEMESTER-IV

Sr. No.	Course Code	Course Name	L	T	P	Credits
1	RA3CO43	Design of Machine Elements and Transmission Systems	3	0	2	4
2	RA3CO30	CNC Machine and Metrology	3	0	2	4
3	RA3CO31	Automatic Control Systems	3	0	0	3
4	RA3CO32	Python for Robotics Engineers	3	0	2	4
5	EN3HS04	Fundamentals of Management, Economics & Accountancy	3	0	0	3
6	RA3ELXX	Program Elective - I	3	0	0	3
7	EN3NG10	Soft Skills -II	2	0	0	2
		Total	**20**	**0**	**6**	**23**
		Total Contact Hours	**28**			

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO43	Design of Machine Elements and Transmission Systems	3	0	2	4

Course Learning Objectives (CLO's):

CLO_{01}: Gain a comprehensive understanding of the fundamental principles of machine elements and transmission systems, including material selection, stress analysis, and failure criteria.

CLO_{02}: Develop the ability to design various machine elements such as shafts, bearings, gears, and springs, considering real-world constraints and requirements.

CLO_{03}: Enhance analytical skills to evaluate and predict the performance of machine elements and transmission systems under different loading conditions.

CLO_{04}: Improve problem-solving abilities by tackling complex design problems and developing innovative solutions.

CLO_{05}: Acquire proficiency in using modern design and analysis software tools to model, simulate, and optimize machine elements and transmission systems.

UNIT I: INTRODUCTION

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Selection of Materials –Design against Static and Dynamic Load – Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

UNIT II: DETACHABLE AND PERMANENT JOINTS

Design of Bolts under Static Load, Design of Bolt with Tightening/Initial Stress, Design of Bolts subjected to Fatigue – Keys -Types, Selection of Square and Flat Keys-Design of Riveted Joints and Welded Joints

UNIT III: SHAFTS AND COUPLING

Design of Shaft –For Static and Varying Loads, For Strength and Rigidity-Design of Coupling-Types, Flange, Muff and Flexible Rubber Bushed Coupling

UNIT IV: GEARS AND BELT DRIVES

Design of Spur and Helical Gear drives-Design of Belt drives-Flat and V Belts, Design of Rope drives

UNIT V: SPRINGS AND BEARINGS

Design of Helical Spring-Types, Materials, Static and Variable Loads-Design of Leaf Spring-Design of Journal Bearing -Antifriction Bearing-Types, Life of Bearing, Reliability Consideration, Selection of Ball and Roller Bearings

TEXT BOOKS:

1. Joseph Edward Shigley, Charles R. Mischke“ Mechanical Engineering Design”, McGraw Hill, International Edition, 1992

2. Sharma. C.S. and Kamlesh Purohit, “ Design of Machine Elements”, Prentice Hall of India Private Limited, 2003

REFERENCE BOOKS:

1. Bhandari. V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Limited, 2003.

2. Robert L. Norton, “Machine Design – An Integrated Approach”, Prentice Hall International Edition, 2000.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01}: Demonstrate a solid understanding of the fundamental concepts related to machine elements and transmission systems.

CO_{02}: Design and analyze machine elements such as shafts, bearings, gears, springs, and clutches to meet specific requirements and constraints.

CO_{03}: Select appropriate materials for different machine elements based on mechanical properties, cost, and other relevant factors.

CO_{04}: Apply national and international design standards and codes to ensure the designed components meet safety and performance criteria.

CO_{05}: Optimize the design of machine elements for factors such as weight, cost, and manufacturability while maintaining required performance levels.

LIST OF EXPERIMENTS:

1. Study of different types of design considerations used in machine design.
2. Study of selection of materials for given applications.
3. Study of design of mechanical components subjected to fluctuating loads
4. study of selection and design procedure for belt drives and ropes drives
5. Study of selection and design procedure for spur and helical gear drives
6. Study of selection of mechanical springs for various applications
7. Design of shafts based on strength and subjected to axial loads.
8. Study of selection of Ball and Roller Bearings

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO30	CNC Machine & Metrology	3	0	2	4

Course Learning Objectives (CLO's):

CLO_{01}: Gain a comprehensive understanding of the principles and technology behind CNC (Computer Numerical Control) machines.

CLO_{02}: Enhance skills in writing and optimizing CNC programs using various programming languages such as G-code and M-code.

CLO_{03}: Understand the importance of precision and accuracy in machining and how to achieve them through proper CNC machine setup and operation.

CLO_{04}: Learn the fundamental principles and techniques of metrology, including measurement standards, instruments, and methods.

CLO_{05}: Acquire knowledge of quality control processes and the role of metrology in ensuring the quality of manufactured products.

UNIT I: INTRODUCTION TO CNC MACHINE TOOLS

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways

UNIT II: DRIVES AND WORK HOLDING DEVICES

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives -stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moire fringe gratings, encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines

UNIT III: CNC PROGRAMMING

Coordinate system, structure of a part program, G and M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and

turning centre for well known controllers such as Fanuc, Heidenhain, Sinumerik etc., generation of CNC codes from CAM packages.

Unit IV: LINEAR AND ANGULAR MEASUREMENTS

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT V: ADVANCES IN METROLOGY

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM -Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications

TEXT BOOKS:

1. Mechatronics, HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
2. Warren S.Seamers, Computer Numeric Control, Fourth Edition, Thomson Delmar, 2002.
3. Jain R.K. Engineering Metrology, Khanna Publishers, 2005.
4. Gupta. I.C., Engineering Metrology, Dhanpatrai Publications, 2005.

REFERENCES BOOKS:

1. Charles Reginald Shotbolt, Metrology for Engineers, 5th edition, Cengage Learning EMEA,1990.
2. Backwith, Marangoni, Lienhard, Mechanical Measurements, Pearson Education , 2006.
3. Peter Smid, CNC Programming Hand book, Industrial Press Inc., 2000
4. Berry Leathan – Jones, Introduction to Computer Numerical Control, Pitman, London, 1987.
5. Radhakrishnan P Computer Numerical Control Machines, New Central Book Agency, 2002.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01}: Demonstrate a thorough understanding of the basic principles and components of CNC machines.

CO_{02}: Operate CNC machines effectively, including setup, tool selection, and maintenance.

CO_{03}: Achieve high levels of precision and accuracy in machining through proper setup and operation of CNC machines.

CO_{04}: Use various metrology instruments proficiently to measure dimensions, tolerances, and surface finish of machined components.

CO_{05}: Implement quality control procedures to ensure that manufactured parts meet specified standards and tolerances.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01}: Demonstrate a thorough understanding of the fundamental principles of automatic control systems.

CO_{02}: Develop mathematical models of dynamic systems using differential equations and transfer functions.

CO_{03}: Analyze the time-domain behavior of control systems, including transient and steady-state responses.

CO_{04}: Analyze the frequency-domain characteristics of control systems using tools like Bode plots, Nyquist plots, and root locus diagrams.

CO_{05}: Optimize the design of machine elements for factors such as weight, cost, and manufacturability while maintaining required performance levels.

LIST OF EXPERIMENTS:

1. Study of the CNC machine
2. Programming and simulation of a lathe using any CAM package
3. Programming and simulation of a machining centre using any CAM package
4. Programming and operation of a CNC Lathe
5. Programming and operation of a CNC machining centre
6. Measurement of Taper Angle using Sine Bar
7. Optical profile projector – study of profile of gear tooth, screw threads.
8. Tool maker's microscope – to study cutting tool geometry, screw threads.
9. Tool wear and surface finish measurement.

10. Dimensional measurement of machined components using, bore gauge, air gauge and Height master.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO31	Automatic Control Systems	3	0	2	4

Course Learning Objectives (CLO's):

CLO_{01}: Gain a comprehensive understanding of the principles and theories behind automatic control systems.

CLO_{02}: Develop the ability to mathematically model dynamic systems and derive their transfer functions.

CLO_{03}: Learn the methods for designing and synthesizing controllers to meet specific performance criteria.

CLO_{04}: Understand and apply techniques to analyze and ensure the stability of control systems.

CLO_{05}: Develop proficiency in using simulation tools and software to model, analyze, and design control systems.

UNIT I: INTRODUCTION:

Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function - Modeling of physical systems – Mechanical, Thermal, Hydraulic systems and Electric Networks - Transfer function of DC generator, DC servomotor, AC servomotor ,Potentiometer, Synchros, Tachogenerator, Stepper motor - Block diagram - reduction techniques, Signal flow graph – Mason‟ gain formula. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT II: TIME DOMAIN ANALYSIS :

Standard Test signals – Time response of second order system - Time domain specifications – Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feed back control. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT III: FREQUENCY DOMAIN ANALYSIS

Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions).

UNIT IV: SYSTEM STABILITY

Characteristic equation - Routh Hurwitz criterion of stability - Absolute and Relative stability – Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT V: ROOT LOCUS METHOD

Root locus concepts - Construction of root loci – Root contours. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions) STATE SPACE ANALYSIS: Limitations of conventional control theory - Concepts of state, state variables and state model – state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions

TEXT BOOKS:

1. Nagrath I J, and Gopal, M, Control Systems Engineering" Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007

REFERENCE BOOKS:

1. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.
2. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
3. Norman C. Nise S, Control system Engineering", John Wiley and Sons, Singapore, 2004.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01}: Demonstrate a thorough understanding of the fundamental principles of automatic control systems.

CO_{02}: Develop mathematical models of dynamic systems using differential equations and transfer functions.

CO_{03}: Analyze the time-domain behavior of control systems, including transient and steady-state responses.

CO_{04}: Use state-space representation for modeling, analyzing, and designing control systems, including concepts like controllability and observability.

CO_{05}: Utilize simulation tools (e.g., MATLAB/Simulink) to simulate and analyze control systems and validate their performance.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO32	Python for Robotics Engineers	3	0	2	4

Course Learning Objectives (CLO's):

CLO01: Gain a comprehensive understanding of Python programming fundamentals, including data types, control structures, functions, and modules.

CLO02: Develop the ability to use Python for various robotics applications, including sensor data processing, control algorithms, and robot movement.

CLO03: Learn to effectively use Python libraries and tools commonly used in robotics, such as NumPy, SciPy, ROS (Robot Operating System), and OpenCV.

CLO04: Acquire proficiency in using simulation environments and tools (e.g., Gazebo, V-REP) to model, simulate, and test robotic systems.

CLO05: Develop the ability to analyze and visualize robotic sensor data using Python tools and libraries.

UNIT-I INTRODUCTION:

Introduction to Python, Uses of Python programming language/ Python applications, Python strings, String Manipulation – Basic Operations, Slicing & Functions and Methods, Storing Data Using Sets, Lists, and Tuples: Performing operations on sets, Working with lists, Creating and using Tuples.

UNIT-II WORKING WITH NUMPY/MATPLOTLIB:

Numpy, Numpy Library, Arrays, Matrices, Matplotlib library for plotting the data, Figures and axes, Subplots, Grid Spaces, Contour Plots, Surface Plots, Polar Plots.

UNIT-III PROGRAMS ON MECHANICS & MACHINE DESIGN

Projectile Motion, Failure theory plot, Shear force, Bending Moment analysis, Kinematic Analysis, Fatigue Criteria, Simple spring Mass system, SciPy Odeint.

UNIT-IV PROGRAMS ON THERMAL ENGINEERING:

Streamlines of fluid flow, Diesel Cycle Analysis, One-dimensional heat equation, Two-dimensional heat equation, flow pressure distribution.

UNIT-V ADDITIONAL ENGINEERING PROBLEMS:

Newton Raphson method, Linear Differential Problem, Data Interpretation, Data Filter Application.

TEXT BOOKS:

1. "Programming Robots with ROS: A Practical Introduction to the Robot Operating System" by Morgan Quigley, Brian Gerkey, and William D. Smart
2. "Learning Robotics Using Python" by Lentin Joseph
3. "Mastering ROS for Robotics Programming" by Lentin Joseph and Jonathan Cacace

REFERENCES:

1. "Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms" by Nikolaus Correll, Bradley Hayes, and David Tolpin
2. "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili
3. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01}: Demonstrate proficiency in Python programming, including writing clean, efficient, and well-documented code.

CO_{02}: Implement control algorithms for robotics applications, such as PID control and state estimation, using Python.

CO_{03}: Apply computer vision techniques using Python and OpenCV to enable robots to perceive and understand their surroundings.

CO_{04}: Utilize Python and machine learning libraries (e.g., TensorFlow, scikit-learn) to develop intelligent robotic systems.

CO_{05}: Develop and implement complete robotics projects, demonstrating the integration of sensors, control systems, and algorithms using Python.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
EN3HS04	Fundamental Management, Economics and Accountancy	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO)

CLO01 To introduce with the Fundamental knowledge of Management.

CLO02 To give knowledge about the Marketing and Human Resource Management.

CLO03 To provide basic information of Applied Economics.

CLO04 To get acquainted with the knowledge of Financial Accounting.

CLO05 To give sufficient knowledge of Financial Management.

UNIT I CONCEPTS OF MANAGEMENT:

Definition, characteristics and importance of management; Management: Science or Art,Difference between Management and Administration, Levels of management, Functions ofManagement, Managerial Roles, Managerial skills and competencies; Decision Making:Definition, process and types; Decision making under certainty, uncertainty and risk; Cross cultural issues in management and challenges.

UNIT II FUNDAMENTALS OF MARKETING AND HUMAN RESOURCE MANAGEMENT:

Introduction to Marketing: Definition, importance, function and scope of marketing, Core concepts of marketing, Marketing concepts and orientations, Marketing environment, Marketing-mix, Holistic marketing concept, Customer Relationship Management (CRM).Introduction to Human Resource Management (HRM): Nature, Scope, Objectives and Functions; Role of HR manager, Process and need for Human Resource Planning, Human resource policies, Changing role of Human Resource in India, Globalization and its impact on Human Resource.

UNIT III FUNDAMENTALS OF ECONOMICS:

Definition, nature, scope and significance; Difference between micro and macro economics; Time value of money, Law of diminishing marginal utility; Theory of Demand and Supply, Price elasticity of demand; Meaning and types of costs, Law of variable proportions; Types of market structure; National income and related aggregates; Meaning and types of Inflation; Meaning and phases of business cycle.

UNIT IV BASIC ACCOUNTING PRINCIPLES:

Accounting Principles and Procedure, Double entry system, Journal, Ledger, Trail Balance, Cashbook; Preparation of Trading, Profit and Loss Account; Balance sheet; Cost Accounting: Introduction, Classification of costs, Methods and Techniques of costing, Cost sheet and preparation of cost sheet; Breakeven Analysis: Meaning and its application.

UNITV FUNDAMENTALS OF FINANCIAL MANAGEMENT:

Introduction of Business Finance: Meaning, Definition of Financial Management, Goals of Financial Management (Profit Maximization and Wealth Maximization), Modern approaches to Financial Management — (Investment Decision, Financing Decision and Dividend Policy Decisions).

TEXT BOOKS:

1. R. D. Agarwal, Organization and Management, McGraw Hill Education.
2. P. C. Tripathy and P. N. Reddy, Fundamentals of Management, Economics and Accountancy Tata McGraw Hill
3. Kotler Philip and Keller Kevin Lane, marketing Management Pearson

REFERENCE BOOKS:

1. Peter F Drucker, The Practice of Management McGraw Hill
2. Harold Koontz, Essentials for Management, Tata McGraw Hill
3. M Y Khan and P K Jain, Management Accounting Tata McGraw Hill

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01}	Explain the Basics of Management Theory.
CO_{02}	Apply Gaining knowledge of Marketing & Human Resource Management.
CO_{03}	Explain the basic information for Economics.
CO_{04}	Get acquainted with the Financial Accounting System.
CO_{05}	Explain and apply various fundamentals of Financial Management.

Program Elective – I

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL08	Machine Learning	3	0	0	3

Course Learning Objectives (CLO's):

CLO$_{01}$: To understand the underlying concepts about Machine Learning.

CLO$_{02}$: To understand the importance of Linear Algorithms

CLO$_{03}$: To understand the concepts of Non-Linear Algorithms.

CLO$_{04}$: To understand the Data Preprocessing and Dimensionality Reduction, Clustering Analysis

CLO$_{05}$: To understand the concept of Time Series Analysis and Forecasting.

Unit-I: Introduction to Machine Learning:

Supervised Machine Learning, Unsupervised Machine Learning, Semi-Supervised Machine Learning, Bias Error, Variance Error, Bias-Variance Trade-Off, Statistical Fit, Overfitting in Machine Learning, Underfitting in Machine Learning, A Good Fit in Machine Learning, How to Limit Overfitting.

Unit-II: Linear Algorithms:

Linear Regression, Logistic Regression, Gradient Descent for Machine Learning, Batch Gradient Descent, Stochastic Gradient Descent, Linear Regression Using Gradient Descent, Logistic Regression by Stochastic Gradient Descent, Linear Discriminant Analysis, Representation of LDA Models, Making Predictions with LDA, Preparing Data For LDA.

Unit –III: Non-Linear Algorithms:

Classification and Regression Trees, Decision Trees, CART Model Representation, Naive Bayes, K-Nearest Neighbors, Learning Vector Quantization, Support Vector Machines, Maximal-Margin Classifier, Soft Margin Classifier, Support Vector Machines (Kernels), Training SVM With Gradient Descent, Learn an SVM Model from Training Data,Make Predictions with SVM Model.

Unit IV: Data Preprocessing and Dimensionality Reduction, Clustering Analysis

Dealing with missing data, Handling categorical data, Partitioning a dataset in training and test sets, Bringing features onto the same scale , Selecting meaningful features , Assessing feature importance with random forests, Unsupervised dimensionality reduction via principal component analysis , Supervised data compression via linear discriminant analysis , Using

kernel principal component analysis for nonlinear mappings, Grouping objects by similarity using k-means ,Organizing clusters as a hierarchical tree ,Locating regions of high density via DBSCAN.

Unit V: Time Series Analysis and Forecasting:

Time Series Patterns, Horizontal Pattern, Trend Pattern, Seasonal Pattern, Forecast Accuracy, Moving Averages and Exponential Smoothing, Moving Averages, Weighted Moving Averages, Exponential Smoothing, Trend Projection, Linear Trend Regression, Holt's Linear Exponential Smoothing, Nonlinear Trend Regression, Seasonality and Trend, Seasonality Without Trend, Seasonality and Trend, Models Based on Monthly Data, Time Series Decomposition, Calculating the Seasonal Indexes, Deseasonalizing the Time Series, Using the Deseasonalized Time Series to Identify Trend.

Text Books:

1. Master Machine Learning Algorithms by Jason Brownlee
2. Statistics for Business and Economics by Anderson, Sweeney and Williams
3. Deeper Insights into Machine Learning by BIRMINGHAM(Packt)

Reference Books:

1. Using Multivariate Statistics - Barbara G. Tabachnick, Linda S. Fidell, Pearson
2. Introduction to Machine Learning – Ethem Alpaydm, The MIT Press

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO_{01}: Examine with many of the ML introduction Concepts.

CO_{02}: Demonstrate about importance of Linear Algorithms

CO_{03}: Demonstrate about importance of Non-Linear Algorithms

CO_{04}: Examine with Data Preprocessing, Clustering Analysis

CO_{05}: Experiment with Time Series Analysis and Forecasting

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL09	Industrial Automation	3	0	0	3

Course Learning Objectives (CLO's):

CLO01: To gain a comprehensive understanding of the principles and components of industrial automation systems.

CLO02: To develop the ability to design and implement control systems for automated industrial processes.

CLO03: To enhance skills in programming industrial automation systems, including PLC programming and scripting for automation software.

CLO04: To analyze, and utilize data from automated systems for process optimization and decision-making.

CLO05: To gain knowledge of safety standards and practices in industrial automation to ensure safe operation of automated systems.

Unit-I

Factory Automation and Integration: Basic concepts, types of automation, automation strategies, automation technologies, applications around us and in manufacturing industries

Unit-II

Hydraulics and Pneumatics: Basic elements of hydraulics/pneumatics, fluid power control elements and standard graphical symbols for them, hydraulic & pneumatic cylinders, Circuit design approach and real time examples; sequence operation of two/more than two cylinders as per the design requirement to automate the systems.

Unit –III

Electro-Pneumatic Logic Control Circuits: Electropneumatic systems, solenoid valves, different sensors, factory automation sensors, electrical sensors, process automation sensors and their interfaces as per application criteria.

Unit IV

Introduction to Micro-Electro-Mechanical Systems (MEMS), Mechanical sensor and actuation: Principle, Beam and Cantilever, Microplates, Capacitive effects, Piezoelectric Materials as sensing and actuating elements, Pressure measurement, Thermal sensor and actuation

Unit V

PLC :Evolution of PLC's - Sequential and programmable controllers - Architecture-Programming of PLC - Relay logic Various hardware types of PLC (CPU and I/O modules).Centralized configuration of PLC Ladder logic and ladder diagram

Text Books:

1. Groover, M. P., Automation, Production System & Computer
2. Integrated Manufacturing, Pearson Education Asia (2009).
3. Esposito, A., Fluid Power with Applications, Sixth Edition, Pearson Education (2009).
4. Majumdar, S. R., Pneumatic Systems, McGraw Hill (2005).

Reference Books:

1. Franssila Sami, Introduction to Micro Fabrication, WILEY, 2nd Edition, 2010
2. Nadim Maluf, An Introduction to Micro electro mechanical Systems Engineering,
3. Artech House, 3 rd edition, 2000.
4. Mahalik Nitai gour Premchand, MEMS, McGraw-Hill, 2007

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO_{01}	Demonstrate a solid understanding of the fundamental principles and components of industrial automation systems.
CO_{02}	Design and implement control systems for automated processes, including feedback and feed forward control strategies.
CO_{03}	Integrate various automation components and systems, such as sensors, actuators, controllers, and communication networks, to create a complete automation solution.
CO_{04}	Apply safety standards and best practices in the design, implementation, and operation of industrial automation systems.
CO_{05}	Diagnose and troubleshoot issues in industrial automation systems, ensuring minimal downtime and optimal performance.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
EN3NG10	Soft Skills-II	2	0	0	2

CLO_{01} Understand the principles of body language and professionalism to effectively present oneself in interviews and group discussions.

CLO_{02} Apply team-building techniques to improve collaboration and achieve team success through practical activities and real-life examples.

CLO_{03} Analyse goal-setting techniques using the SMART method to effectively plan and achieve personal and professional goals.

CLO_{04} Evaluate different time management strategies, such as prioritization and scheduling, to enhance productivity and meet deadlines.

CLO_{05} Create and perform realistic shopping dialogues to practice and improve conversational skills in everyday scenarios.

UNIT I Body Language and professionalism:

To make participants aware of the importance of Body language trains them to project a better outlook of themselves. This helps in presenting themselves in Personal interview and Group discussions. Grooming and presenting oneself are the main focus. Interview dress code, facial expressions, body language, handshake etiquettes etc., are dealt in the session. Worksheets, anecdotes, videos and role-plays are some of the important components of the session. Interpersonal skills: Effective interpersonal skills are crucial to increase employment opportunities and to compete in the business environment. This session makes the participants understand different barriers to proper interpersonal communication and to tackle them head-on. Activities are an integral component of the session. Reporter: The aim of the session is to make every student ask rational questions and make diplomatic replies. The session is a press meets like group activity session.

UNIT II Team Building:

To make every student intermingle within a team and contribute to the team's success. To make them understand the importance of working as a team. Importance of complimentary skill sets, and synergy effects of a team are proved using real-life examples and classroom activities. Picture connector: To make the students participate in group interactions, create dialogue and present on the stage. Students link various pictures from newspaper to come up with a pictorial representation of a story or idea and narrate/present the same. Creativity and presentation skills are concentrated. Students also learn to connect various variables and come up with concrete ideas.

UNIT III Time and work:

Work with different efficiencies, Pipes and cisterns, Work equivalence, Division of wages Goal Setting: To make students goal oriented and to help them realize and sketch their personal and professional goals. SMART goal technique for goal setting is taught and explained using examples. Students will be encouraged to set a personal and career goal based on the SMART technique. Tactics to deal with hurdles for attaining the goals are dealt. Famous goal setting success stories are shared to boost confidence.

UNIT IV Time Management:

To make students understand the value of time and effective management of their time. Paper tower activity helps students practically experience the importance of managing time and to improve at it. Time management grid helps students understand the importance of prioritizing.

Tourism pitch: The session makes students present and promotes their choice of tourist spot or their favourite city in order to convince the client (trainer) to visit the city. Presentation skills are enhanced. Teamwork is practiced during the preparation phase of the activity.

UNIT V Shopping role play:

To enable students to frame dialogues for their day-to-day life scenarios. A shopping scenario has to be mimicked by the students with impromptu conversation. This helps them in practicing speaking in English in their daily conversations. Sample everyday conversations are presented for practical learning. Shipwreck: The main objective of this is to enhance the skill capacity of the students to think out of the box and try to enhance the cognitive thinking capability. Play teacher: The session makes students understand the different values and virtues like empathy- by which they will try to enact the scenario given to them try solving the problem like an adviser.

CO_{01} Understand the significance of body language and professional attire in enhancing communication during interviews and group discussions.

CO_{02} Apply effective team-building strategies to foster collaboration and improve team performance in group activities.

CO_{03} Analyze the principles of goal setting using the SMART technique to establish and evaluate personal and professional objectives.

CO_{04} Evaluate the effectiveness of various time management techniques, such as prioritization and scheduling, in improving personal productivity.

CO_{05} Create and conduct a role-play exercise that demonstrates effective conversational skills and impromptu dialogue in everyday shopping scenarios.

SEMESTER – V

Sr. No.	Course Code	Course Name	L	T	P	Credits
1	RA3CO37	Electrical Machines and Power Systems	3	0	2	4
2	RA3CO48	Principles of Robotics	4	0	2	5
3	RA3CO49	Embedded Systems	3	0	0	3
4	RA3CO50	Digital Image Processing	3	0	2	4
5	RA3ELXX	Program Elective - II	3	0	0	3
6	RA3ELXX	Program Elective - III	3	0	0	3
7	OE000XX	Open Elective- I	3	0	0	3
8	EN3NG09	Soft Skills -III	2	0	0	2
		Total	**24**	**0**	**6**	**27**
		Total Contact Hours	**30**			

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO37	Electrical Machines and Power Systems	3	0	2	4

Course Learning Outcomes (CLO's):

CLO_{01} - To understand the principle of operation, construction, equivalent circuit and different testing of transformer, efficiency and regulation of transformer.

CLO_{02} - To know about DC motor construction, principle, characteristics and efficiency.

CLO_{03} -To describe about the construction, principle, testing, characteristics and speed control methods of 3-phase induction motor and to describe the starting methods of 1-phase induction motor.

CLO_{04} – To gain idea about special motors like Stepper motor, Servomotor, BLDC and PMSM.

CLO_{05} - To describe the structure of power system and different power plants.

Unit-I

Transformers: Constructional details, types, Principle of operation, Transformation ratio, EMF equation, Transformer on no load, Parameters referred to HV/LV windings, Equivalent Circuit, Transformer on load, Testing – Open and short circuit tests, Load test, Efficiency and Voltage regulation, Autotransformer, 3- phase transformers connections.

Unit-II

DC Machines: DC Motor: Construction, principle of operation, Different types of DC motors, Voltage equation of a motor, significance of back EMF, Speed, Torque, Torque-Speed characteristics, Output Power, Efficiency and applications.

Unit-III

Three Phase Induction Motor: Constructional features, Rotating magnetic field, Principle of operation, Phasor diagram, Equivalent circuit, Torque and power equations, Torque- slip characteristics, No load & blocked rotor tests, Efficiency, Starting, Speed control.

Single phase Induction Motor: Double revolving field theory, Equivalent circuit, Starting methods, Repulsion motor, Universal motor.

Unit-IV

Control Motors: Stepper Motors: Constructional features, Principle of operation, Types, Hybrid stepper motor, Modes of excitation and applications.

Servomotors: Types, Constructional features, Principle of operation and applications.

Permanent Magnet Brushless DC Motors: Principle of operation, Types, control of BLDC Motors, Applications.

Permanent Magnet Synchronous Motors: Principle of operation, control of PMSM Motors, Applications.

Unit-V

Introduction to Power System: Structure of electric power systems– generation, transmission, sub-transmission and distribution systems, Conventional and nonconventional energy sources, hydroelectric – thermal and nuclear power plants - detailed layout - explanation and comparison.

Text-Books:

1. I J Nagrath & D.P. Kothari, "Electrical Machines", Tata McGraw Hill.
2. B. R. Gupta, Generation of Electrical Energy, S. Chand Publication.
3. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
4. Electrical Machinery by Fitzerald, Kingsley and Umans, McGraw Hill Int. Book Co

Reference Books:

1.Fitzgerald A. E., C. Kingsley and S. Umans, Electric Machinery, 6/e, McGraw Hill, 2003.
2.Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
3.I. J. Nagrath and D. P. Kothari, “Modern Power System Analysis”, Tata McGraw Hill

Course Outcomes (CO's):

After the completion of this course the students shall be able to:

CO_{01} – Explain principle of operation, draw equivalent circuit and explain different testing of transformer.

CO_{02} – Compare different types of motors and explain different characteristics of motors.

CO_{03} - Apply the data of no load and blocked rotor test to determine efficiency of 3-phase induction motor.

CO_{04} - Differentiate BLDC and PMSM and explain principle of Stepper motor and servomotor.

CO_{05} – Draw one line diagram of power system and describe about different power plants.

List of Experiments:

1. To perform OC and SC tests on a 1-phase transformer and determine its equivalent circuit.
2. To perform No-load and block rotor test on a 3-phase IM and determine its equivalent circuit.
3. To perform load test on a 3-phase IM and plot its performance characteristics.
4. To perform back-to-back (Sumpner's) test on transformer.
5. To perform speed control of three phase induction motor using input voltage control.
6. To plot magnetization characteristic of a separately excited DC generator.
7. To perform load test on DC shunt motor.
8. To study of Servo Motor.
9. To study of Stepper Motor.
10. To study of BLDC Motor.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO48	Principle of Robotics	4	0	2	5

Course Learning Objectives (CLOs):

CLO_{01} To introduce the functional elements of Robotics.

CLO_{02} To impart knowledge on the direct and inverse kinematics.

CLO_{03} To impart knowledge on differential motion and static analysis of manipulator

CLO_{04} To impart knowledge on position and orientation analysis for path planning.

CLO_{05} To impart knowledge on dynamics and control of manipulators.

UNIT I : BASIC CONCEPTS

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors – work cell – Programming languages.

UNIT II: DIRECT AND INVERSE KINEMATICS

Mathematical representation of Robots – Position and orientation – Homogeneous transformation-Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics-PUMA560 & SCARA robots- Solvability – Solution methods-Closed form solution.

UNIT III: MANIPULATOR DIFFERENTIAL MOTION AND STATICS

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints Inverse -Wrist and arm singularity – Static analysis – Force and moment Balance.

UNIT IV: PATH PLANNING

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

UNIT V: DYNAMICS AND CONTROL

Lagrangian mechanics -2DOF Manipulator-Lagrange Euler formulation-Dynamic model –Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

TEXT BOOKS:

1. R.K. Mittal and I.J. Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. John J. Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. M.P.Groover, M. Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill

REFERENCE BOOKS:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D. Klafter, T.A. Chimielewski and M. Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

List of Practicals:

1. Determination of maximum and minimum position of links.

2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system

3. Estimation of accuracy, repeatability and resolution.

4. Robot programming and simulation for pick and place

5. Robot programming and simulation for Colour identification

6. Robot programming and simulation for Shape identification

7. Robot programming and simulation for assembly process

8. Trajectory Control Modeling with Inverse Kinematics

9. Check for Environmental Collisions with Manipulators

10. Robot programming for joint torque calculation.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} – Demonstrate a thorough understanding of the fundamental principles and theories underlying robotics.

CO_{02} – Develop dynamic models of robots to predict and analyze their motion under various forces and torques.

CO_{03} - Integrate various sensors into robotic systems to gather and process environmental data.

CO_{04} - Understand and implement different types of actuators to control robot movements.

CO_{05} – Apply perception algorithms for tasks such as object recognition, path planning, and environment mapping.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO49	Embedded Systems	3	0	0	4

Course Learning Objectives (CLO's):

CLO_{01} Develop an understanding of the technologies behind the embedded computing systems.

CLO_{02} To introduce students to the design issues of embedded systems.

CLO_{03} Enable students to analyze and develop software programs for embedded systems.

CLO_{04} Understand the use and interfacing of various peripherals and I/O devices in embedded systems.

CLO_{05} Develop the ability to design and develop embedded systems for various applications.

Unit – I

Introduction to embedded systems: Introduction to Embedded Systems, Microprocessor vs Microcontroller, different microcontroller architecture, AVR Microcontrollers, The Arduino Platform, Block diagram, Architecture, Arduino Boards Pin functions, Overview of main features such as – I/O ports, timers, interrupts Serial port, PWM, ADC etc

Unit – II

Arduino Schematics, Concept of C-Language, C vs Embedded C, Introduction to Arduino IDE, Writing, Saving, Compiling and Uploading Sketches., Hello world program.

If-Programming and interfacing of LED, Relay, Switch, LCD, Servo motor, dc motor, Interfacing, and programming of sensors: IR, Soil sensor.

Unit – III

Interfacing and Programming Digital Output Programming by discrete LED interface, Timer & delay time function, 7-segment LED programming, Buzzer interface, and programming.

Digital Input Programming by interfacing Switches, Analog out (PWM) programming using RGBLED interface. Analog Input Programming using POT.

Unit – IV

Introduction to IoT: Fundamental of Computer Networking, IP address, LAN, WAN, WiFi, IoT for robotics and automation, ESP32 Controller architecture , pin description , interfacing and programming of LED, relay, DHT sensor and application design using ioT

Unit – V

Cloud Server Types of Servers, Network architecture of cloud server, MySQL database, PHP script - GET & POST protocol , API keys, Setting up iot server, MQTT, HTTP protocol and applications

Text Books:

1. Raj Kamal, "Embedded Systems", 2nd edition, Tata McGraw Hill, 2009.
2. Lyla B Das, "Embedded Systems an Integrated Approach", 1st edition, Pearson,2012.

Reference Books:

1."Beginning with Arduino", by Michael McRoberts,
2."Arduino Cookbook", by Michael Margolis,
3."Getting Started with Arduino", by Massimo Banzi

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO_{01}	Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems..
CO_{02}	Become aware of the architecture of the processor/ controller and its programming aspects
CO_{03}	Interfacing and programming of different types of sensors
CO_{04}	Understand hardware and software design requirements of embedded systems.
CO_{05}	Analyze the embedded systems' specification and develop applications

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO50	Digital Image Processing	3	0	2	4

Course Learning Objectives (CLO's):

CLO01	To Impart the Introductory Concepts of Image Processing.
CLO02	To understand all the Elements of Image Processing Beginning from Formation and Digitization to Enhancement, Restoration.
CLO03	Image Enhancement Techniques Used in Digital Image Processing.
CLO04	Image Compression and Segmentation Used in Digital Image Processing
CLO05	Image recognition and shape identification used in Digital Image Processing

Unit I: Introduction

Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System -Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry. Image File Formats: BMP, TIFF and JPEG. Colour Models (RGB, HSI, YUV).

Unit II: Image Enhancement and Representation:

Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background-Smoothing Filters, Sharpening Filters, Low Pass Filtering, High Pass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. Homomorphic Filtering, Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique, Image Representation and Description, Chain Code, Polygonal, Representation, Shape Number, Moments.

Unit III: Image Segmentation and Binary Image Processing

Segmentation: Mean Shift Segmentation – Active Contour Models – Geometric Deformable Models – Fuzzy Connectivity – 3D Graph Based Image Segmentation – Graph Cut Segmentation - Optimal Surface Segmentation. Shape Representation and Description: Hough Transform – Hadamard Transform - Region Identification – Contour Based and Region Based Shape Representation and Description – Shape Classes, Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Connected Component Labeling, Iterative Algorithm and Classical Algorithm.

Unit IV: Image Transform

Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two- Dimensional Fourier Transform Fast Fourier Transform(FFT), Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT), Fundamentals – Coding Redundancy, Inter-pixel Redundancy, Psych visual Redundancy, Fidelity Criteria.

Unit V: Image Restoration and Compression

Model of Image Degradation/Restoration Process - Noise Models - Inverse Filtering – Least Mean Square Filtering - Constrained Least Mean Square Filtering. Edge Detection - Thresholding - Region Based Segmentation - Boundary Representation, Image Compression Models – The Source Encoder and Decoder, Lossless Compression Techniques: Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM, Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.

Text Books:

1.Digital Image Processing – by R.C. Gonzalez And R.E. Woods,, 2nd Ed., Prentice Hall Of India, New Delhi.

2.M. Sonka, V. HlavacAnd R. Boyle, Image Processing Analysis And Machine Vision, Brooks/Colic, Thompson Learning, 1999.

Reference Books:

1. Image Processing, Analysis And Machine Vision: Milan Sonka, Vaclav Hlavac, Roger Boyle (Thomson Brooks / Cole Edition).

2. Fundamentals of Digital Image Processing: Anil K. Jain (Prentice Edition Hall Of India)

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO_{04}	Understand and apply image restoration techniques to remove noise and correct
CO_{01}	Get Familiarize with Basic Image Processing Techniques for Solving Real Problems
CO_{02}	Implement Image Process and Analysis Algorithms.
CO_{03}	Design and Create Practical Solutions to Range of Common Image Processing Problems blurring, including deblurring methods and noise reduction algorithms.
CO_{05}	Extract and represent features from images using techniques such as edge detection, corner detection, and texture analysis.

List of Practicals:

1. Write a program to read and display an image in different file formats (BMP, TIFF and JPEG) and color models (RGB, HSI, YUV).

2. Write a program to perform histogram equalization and contrast stretching on a given image.

3. Write a program to implement spatial domain filters (smoothing and sharpening) and frequency domain filters (low pass and high pass) on a given image.

4. Write a program to implement edge detection using Sobel, Prewitt and Canny operators on a given image.

5. Write a program to perform Hough transform for line and circle detection on a given image.

6. Write a program to perform image segmentation using thresholding, region growing and split and merge techniques on a given image.

7. Write a program to perform morphological operations (erosion, dilation, opening, closing) on a binary image.

8. Write a program to perform image representation and description using chain code, polygonal approximation and shape number on a given image.

9. Write a program to implement image transforms (DFT, DCT, DWT) on a given image and compare their properties and applications.

10. Write a program to implement image restoration using inverse filtering and Wiener filtering on a noisy image.

Program Elective-II

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL07	Artificial Intelligence	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO 01 To learn the basic AI approaches and design and implement search strategies

CLO 02 To gain knowledge of key AI algorithms and model

CLO 03 To perform logical and probabilistic reasoning

CLO 04 To understand game playing techniques

CLO 05 To understand various type of learning

UNIT I INTRODUCTION

Meaning and definition of artificial intelligence, various types of production systems, Characteristics of production systems, Study and comparison of breadth first search and depth first search. Techniques, other Search Techniques like hill Climbing, Best first Search. A* algorithm, AO* algorithms etc, and various types of control strategies.

UNIT II KNOWLEDGE REPRESENTATION

Knowledge Representation, Problems in representing knowledge, knowledge representation using propositional and predicate logic, comparison of propositional and predicate logic, Resolution, refutation, deduction, theorem proving, inferencing, monotonic and no monotonic reasoning.

UNIT III PROBABILISTIC REASONING

Probabilistic reasoning, Bayes theorem, semantic networks scripts schemas, frames, conceptual dependency, fuzzy logic, forward and backward reasoning.

UNIT IV GAME TECHNIQUES

Game playing techniques like minimax procedure, alpha-beta cut-offs etc, planning, Study of the block world problem in robotics, Introduction to understanding and natural languages processing.

UNIT V NEURAL NETWORKS

Introduction to learning, Various techniques used in learning, introduction to neural networks, applications of neural networks, common sense, reasoning, some example of expert systems.

TEXT BOOKS:

1. Rich E and Knight K, Artificial Intelligence, TMH, New Delhi.
2. Nelsson N.J., Principles of Artificial Intelligence, Springer Verlag, Berlin.

REFERENCE BOOKS:

1. Waterman D.A., A guide to Expert System, Addison Wesley, Reading (Mars).
2. Giarratand & Riley, Expert Systems: Principles and Programming, Thomson.

COURSE OUTCOMES (CO's):

After the completion of this subject students will be able to:

CO 01 Explain different types of searching techniques

CO 02 Represent knowledge

CO 03 Apply logical reasoning

CO 04 Apply game playing and CSP techniques

CO 05 Explain various types of learning

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL10	Industrial Robotics and Material Handling Systems	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO01 To understand the basics of manipulators and types of industrial robots.

CLO02 To know about the various drive systems for robot, sensors and their applications

CLO03 To know the various industrial applications of robots.

CLO04 To understand the design and force analysis of the end-effector.

CLO05 To understand the industrial material handling systems.

UNIT I INTRODUCTION

Robotic arm components and working, types of industrial robots, load handling capacity, general considerations in robotic material handling, material transfer, machine loading and unloading, robot centered cell.

UNIT II ROBOTIC VISION

Robotic vision systems, image processing and analysis, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

UNIT III INDUSTRIAL APPLICATIONS

Important applications of robots in various sectors, Factors influencing the selection of a robot, robot performance testing, economics of robotisation, application of robots in continuous arc welding, spot welding, spray painting, assembly operation, cleaning, robot for underwater applications, impact of robot on industry and society.

UNIT-IV END EFFECTORS

Types of end effectors, Mechanical grippers, other types of gripper, active and passive grippers, tools as end effector, the robot/end effector interface, considerations in gripper selection and design, Gripper force analysis, design of multiple degrees of freedom,

UNIT-V MATERIAL HANDLING

Concepts of material handling, principles and considerations in material handling systems design, advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems, barcode technology, radio frequency identification technology.

TEXT-BOOKS:

1. Mikell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, John Wiley & sons
2. Ramachandran Nagarajan, Introduction to industrial robotics, Pearson
3. S. K. Saha, Introduction to Robotics, McGraw Hill Education

REFERENCE BOOKS:

1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, "Robotic Engineering-An integrated Approach" Prentice Hall India,
2. Mikell P. Groover, Industrial Robotics, Tata McGraw Hill India

COURSE OUTCOMES (COs):

After the completion of this course the students shall be able to:

CO_{01} Understand the working of industrial robots.
CO_{02} Apply suitable principles and controls in designing automatic manufacturing cells
CO_{03} Compare and select an appropriate robot for industrial applications.
CO_{04} Analyze and select suitable end effector.
CO_{05} Identify appropriate material handling systems.

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PROGRAM ELECTIVE – III

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL24	Smart Sensors	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO's):

CLO$_{01}$ To understand the operation of different types of sensors and microsystems.

CLO$_{02}$ To design sensors with appropriate electronic interfaces as a complete system.

CLO$_{03}$ To discuss how sensors enable data collection and automation in IoT applications

CLO$_{04}$ To evaluate the trade-offs in choosing specific sensor technologies for different applications.

CLO$_{05}$ To understand the ethical and privacy considerations related to the use of smart sensors, especially in data collection and management.

UNIT I INTRODUCTION

Definition and Classification of Sensors- Self-calibration, Self-testing & self-communicating, Selection criteria for sensing technologies, Sensor Components, Communication interfaces, Architecture of Smart Sensors, Integration with microcontrollers and microprocessors, Importance of sensors in modern technology, Advantages and disadvantages of smart sensors, Sensing Technologies, Overview of different sensing technologies (e.g., chemical, optical, thermal),

UNIT II TYPES OF SENSORS

Acoustic Sensors, Mechanical Sensors, Piezoelectric sensors and materials, Saw sensors, Integrated Hall sensors, Magnetic sensors, Magneto-transistors, other magnetics transistors and future trends, Radiation Sensors, Thermal Sensors and Chemical Sensors, Radiation basics - HgCdTe infrared sensors, Visible-light color sensors - high-energy photodiodes, Interaction of gaseous species at semiconductor Surfaces - Catalysis - the acceleration of chemical reactions - Thin-film sensors - FET devices for gas and ion sensing.

UNIT III MEMS FABRICATION

Micro-and Nanotechnologies or Sensors - Fundamentals of MEMS fabrication, introduction and description of basic processes, MEMS fabrication technologies, bulk micromachining, Surface micromachining, High- aspect-ratio (LIGA and LIGA-Like) technology

microfluidics microsystem components, Microfluidics microsystem components, Nanotechnology - product prospects - application trends Procedures and techniques, the making of ultrathin films Creation of lateral nanostructures - clusters and Nano crystalline materials and principles of self-organization and Future trends.

UNIT IV IoT INTEGRATION

IoT Basics, Introduction to IoT and its components, Role of sensors in IoT, Integration of Smart Sensors with IoT, Communication protocols (e.g., MQTT, CoAP), Cloud computing for data storage and analysis

UNIT V SENSOR FABRICATION

Fabrication of Sensor and Smart Sensor, Integration of Micromachining and Microelectronics, Wafer bonding, Standard of Smart Sensor Network, Communication for smart sensors, Role of smart sensors in environmental monitoring, smart grids, battlefield reconnaissance, exploration, Industrial applications of smart sensors, emerging technologies in sensor development, challenges and opportunities in smart sensor implementation

TEXT BOOKS:

1.Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer; 4th ed. 2010.

2. S. M. Sze, "Semiconductor Sensors", Wiley-Interscience, 1994.

REFERENCES:

1. Gerard Meijer, "Smart sensor systems", Wiley, 2008.

2. W Gopel, J. Hesse, J. N. Zemel, "Sensors A Comprehensive Survey", Vol. 9, Wiley-VCH, 1995.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO_{01} Understand the operation of different types of sensors and microsystems.

CO_{02} Design the sensors with appropriate electronic interface as a complete system.

CO_{03} Analyze and apply sensors in robotics and automation.

CO_{04} Design and fabricate the process of MEMS fabrication.

CO_{05} Diagnose and resolve issues in smart sensor systems, ensuring proper maintenance and optimal performance of the sensors and associated systems.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL26	Neural Networks	3	0	0	3

COURSE LEARNING OBJECTIVES (CLO'S):

CLO01 The fundamental concepts of Neural Networks

CLO02 To familiarize with artificial learning processes.

CLO03 To introduce different neural network architectures and selection process.

CLO04 To develop skills in evaluating neural network models using appropriate metrics, cross-validation methods, and performance analysis techniques.

CLO05 Apply neural network techniques to solve real-world problems in various domains such as image recognition, natural language processing, and time series forecasting.

UNIT I INTRODUCTION TO NEURAL NETWORK SYSTEM

Introduction to Neural Network System: Introduction to biological neurons and their artificial models, history of artificial neural systems development, Simple Memory and Restoration of Patterns, basic concepts related to neural networks: three layers of neural network systems, units, connections, site, mode, perceptron, single layer and multiple layer perceptron, McCulloch-Pitts Neuron Model, Neuron Modelling for Artificial Neural System, Models of neural networks: feedforward and feedback networks, neural processing.

UNIT II NEURAL NETWORK LEARNING AND ADAPTATION

Neural Network Learning and Adaptation: Introduction to neural network learning and adaptation, learning as approximation or Equilibria Encoding, concepts of supervised and unsupervised learning, neural network learning rules: Hebbian learning rule, perceptron learning rule, delta learning rule, Widrow-Hoff Learning Rule, correlation learning rule, Winner- Take-All learning rule, Outstar learning rule, summary and comparison of artificial neural network learning rules.

UNIT III CLASSIFICATION MODEL

Single Layer Perceptron Classifiers: Introduction to single layer perceptron, classification model, features and decision tree, discriminant functions, linear machine and minimum distance classification, non-parametric training concepts, training and classification using the discrete perceptron, single layer continuous perceptron neural networks for linearly separable classification, multi category single layer perceptron neural networks.

UNIT IV MULTILAYER FEED FORWARD NETWORKS

Multilayer feed forward Neural Networks: Introduction to multilayer perceptron neural networks, linearly non separable pattern classification, delta learning rule for multilayer perceptron networks, generalized delta learning rule, Feedforward recall and error Back-Propagation training, training errors, Multilayer Feed forward Networks as Universal Approximators, Learning Factors: Initial Weights, cumulative weight adjustments vs incremental updating, learning constant and momentum method, classifying and expert layered networks, Character Recognition Application, expert systems applications, learning time sequences.

UNIT V FEEDBACK NEURAL NETWORKS

Single-Layer Feedback Neural Networks: Introduction to single layer feedback neural networks, basic concepts of dynamic systems, Mathematical Foundations of Discrete-Time and gradient type Hopfield Networks, Transient Response of Continuous-Time Networks, Relaxation Modelling in Single-Layer Feedback Networks, Summing Network with Digital Outputs, Minimization of the Traveling Salesman Tour Length.

TEXT BOOK:

1. Introduction to Artificial Neural Systems – Jacek M Zurada, West Publishing Company.
2. An introduction to neural networks - Kevin Gurney, UCL Press.

REFERENCE BOOK:

1. Principles of Artificial Neural Networks, 2 nd Edition - Daniel Graupe, World Scientific Publishing Co. Pte. Ltd.

LIST OF EXPERIMENTS:

1. Design and train perceptron for identifying ODD and EVEN number.
2. Write a program to implement McCulloch-pitts model of Neuron:

● Design and train a perceptron for AND gate.

● Design and train a perceptron for OR gate.

● Design and train a perceptron for EX-OR gate.

● Design and train a perceptron for NOR gate.

3. Create a bidirectional Associative memory (BAM) for ID and telephone number.
4. Design and train the Hopfield net to map the input vector with the stored vector and correct them.
5. Write a program for back propagation algorithm.
6. Write a program to implement Delta rule.
7. Write a program of perceptron training algorithm.
8. Write a program to test and train a dataset (dataset can be anything: eg: wine dataset).
9. Write a program for Error back propagation Algorithm.
10. Write a program to implement Hebb's rule (unsupervised learning algorithm).

COURSE OUTCOMES (CO'S):

After completion of this course the students shall be able to:

CO_{01} Understand the algorithms for multilayer perceptrons and radial basis function networks

CO_{02} Select the appropriate architecture for a given problem

CO_{03} Understand deep learning networks through convolutional networks and its applications

CO_{04} Apply neural networks to classification and recognition problems.

CO_{05} Analyze and address ethical issues related to neural networks, including concerns about bias, fairness, transparency, and the responsible use of AI technologies.

Open Electives-I

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00083	Open Elective-I Value Creation through design thinking	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} To understand the concepts of design thinking and Stages of the design thinking processes.
CLO_{02} To understand the concepts and rules of brainstorming and advanced brainstorming techniques.
CLO_{03} To understand the concepts of prototyping techniques and minimum viable product.
CLO_{04} To understand the concepts of business model canvas and Pivoting.
CLO_{05} To understand the concepts of product development processes.

Unit 1: Define Your Innovation: Overview of Design Thinking, Identifying an Innovation Challenge, Needs Finding, Identifying Assumptions

Identifying Customer Needs: Learn to identify customer needs and draft customer needs statements as your first step towards user innovations.

Design Thinking Skills: Understand the critical design thinking skills needed to either improve an existing product or design a new product, Principles and Stages of the Design Thinking Process

Unit 2: Ideate: Rules of Brainstorming, Brainstorm Facilitation, Advanced Brainstorming Techniques

Applied Creativity: Learn to apply creativity, brainstorming, and concept generation process in designing needs solutions.

Product Specifications: Learn how to translate user needs into product specifications quantitatively, and how establishing product metrics can help to define those specifications.

Unit 3: Prototype: Introduction to Prototyping, Prototyping Techniques, Testing Prototypes, Explore prototyping methods, strategies, and real-life examples where these have been applied to create a design that represents customer needs and product specifications.

Test: Minimum Viable Product (MVP), MVP Testing and Iteration

Unit 4: Business Model Canvas: Learn the Business Model Canvas and How to use it to Design & Develop Solutions

Experiments: Testing Your Business Model, Introduction to Experimental Design, Types of Experiments, When to Pivot After Experimentation, Types of Pivots

Design for Services: Understand design of services, identify the potential for innovations within them, and learn how to apply product development frameworks to the service context.

Unit 5: Design for Environment: Learn how to apply design for environment principles to a product life cycle.

Product Development Processes: Learn to select and implement a product development process (staged, spiral, and agile) that's aligned to your project needs.

Text Books:

1.Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India Private Limited-2020.
2.Don Norman, The Design of Everyday Things, -2014.
3.Nigel Cross, Design Thinking: Understanding How Designers Think and Work- 2019.

Reference Books:

1. Michael Lewrick, Design Thinking for Business Growth: How to Design and Scale Business Models and Business Ecosystems, 1st Edition-2022.
2.Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, Therese Naef, Bernhard Schindlholzer , Design Thinking: The Handbook-2020.
3. Isabell Osann, Lena Mayer, Inga Wiele, The Design Thinking Quick Start Guide: A 6-Step Process for Generating and Implementing Creative Solutions -2020.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To understand the concepts of design thinking and Stages of the design thinking processes.

CO_{02} To understand the concepts and rules of brainstorming and advanced brainstorming techniques.

CO_{03} To understand the concepts of prototyping techniques and minimum viable product.

CO_{04} To understand the concepts of business model canvas and Pivoting.

CO_{05} To understand the concepts of product development processes.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00007	Open Elective-I Mechanical Estimation & Costing	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} To present a problem oriented in depth knowledge of Engineering Costing & Estimating.
CLO_{02} To address the underlying concepts, methods and application of Engineering Costing & Estimating.
CLO_{03} To gain awareness in Estimating cost for new project, lab development, and services.
CLO_{04} To gain awareness in different elements of cost, direct cost and indirect cost for industry.
CLO_{05} To gain awareness in Depreciation, obsolescence and calculating material cost using Menstruation.

UNIT I:

Introduction to Estimation and Costing: Estimation - Definition, Importance and Aims, Qualities and functions of an Estimator, Source of errors in estimation, Constituents of Estimation, Costing - Definition and Aims, Standard cost and its Advantages, Difference between estimation and costing, Advantages of efficient costing.

UNIT II

Elements of Costs: Elements of cost- material, labour and overhead, and examples, Calculation of Material cost-direct, indirect material, Labour - direct, indirect labour and examples, Calculation of labour cost, Overheads - direct, indirect and examples, Classification of overheads - factory, administrative, selling and distribution overheads and example, Fixed and variable overheads and examples, Components of cost - prime cost, factory cost, office cost, total cost, Selling price, Block diagram to show the relationship between elements and components of cost, Numerical problems on above, Allocation of on-cost (overhead) - methods and numerical problems.

UNIT III

Mechanical Estimation: Estimation in machine shop - Definition of cutting speed, feed,depth of cut, Estimation of time for various operations like Turning, Knurling, Facing, Drilling, Boring, Reaming, Threading, Tapping, Milling, Grinding, Shaping and Planing, Estimate the material required for- Sheet metal operation, Cylindrical drum, funnel and tray, Estimation in foundry shop, Estimation in welding shop - gas welding and arc welding - Numerical problems.

UNIT IV

Indirect Expenses and Depreciation: Explain indirect expenses- depreciation, obsolescence, inadequacy, idleness, repair and maintenance, define depreciation and state its causes, (Physical and functional), Explain methods of calculating depreciation, Solve numerical problems on each method.

UNIT V

Mensuration And Estimation Of Material Cost: Mention Area of irregular and plane figures with sketches, Mention Volume and surface area of solids (formulae only), Estimate the material costs of step pulley, spindle lathe centre, Rivets, Fly wheel, crankshaft, chain link, wedge and Gib-headed key-Simple problems only.

Text Books:

1. B.P. Sinha, Mechanical Estimation and Costing, TMH.

2. S.K. Sharma & Savita Sharma, Industrial Engineering & Operations management, Kataria publishers.

3. T.R. Banga and S.C. Sharma, Industrial Organization and Engineering Economics, Khanna Pub.

Reference Books:

1. Shrimali and Jain, Mechanical estimating and costing, Khanna Publishers.

2. Singh and Khan, Mechanical costing and estimation, Khanna Publishers.

3. Dennis Lock, Handbook of Engineering Management, Butterwork & Heinemanky Ltd.

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO_{01}	Understand estimation and types of estimates in day do day life.
CO_{02}	Gain knowledge of different types cost and calculate the selling price of product or services.
CO_{03}	Gain awareness in applications of estimation and costing in mechanical processes.
CO_{04}	Gain awareness in Depreciation and obsolescence.
CO_{05}	Perform risk assessments and manage uncertainties in cost estimation by identifying potential risks and incorporating contingency plans.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00008	Open Elective-I Reliability & Maintenance	3	0	0	3

Course Learning Objectives (CLO's):

CLO1 To acquire awareness about Reliability & Maintenance Eng and its applications.

CLO2 To understand the importance of Maintenance management in organizations

CLO3 To acquire Knowledge of reliability, and know about design and measures of reliability.

CLO4 To understand the concept of various probability distribution curves.

CLO5 To understand the different system reliability model and redundancy techniques.

Unit 1 Basic Concepts of Reliability: Probability distributions used in maintenance engineering, Binomial, Poisson, Exponential, Normal, Log-normal, Gamma and Weibull distribution; failure rate, hazard rate, failure modes, MTTR, MTBF, MTTF.

Unit 2 System Reliability Models: System reliability–n-component series systems, m-component, parallel systems and combined system; standby systems; K-out-of-m systems; redundancy techniques, in system design; event space, decomposition (Key Stone), cut and tie sets, Markov analysis, reliability and quality, unreliability, maintainability, availability.

Unit 3 Maintenance Concepts and Strategies: Introduction, maintenance functions and objectives, maintenance planning and scheduling, maintenance organization. General Introduction to Maintenance Types: Breakdown, emergency, corrective, predictive, and preventive; maintenance prevention; design-out maintenance, productive maintenance, shutdown maintenance and scheduled maintenance.

Unit 4 Condition Based Maintenance: Principles of CBM, pillars of condition monitoring, CBM implementation and benefits; condition monitoring techniques- visual monitoring, vibration monitoring, wear debris monitoring, corrosion monitoring, performance monitoring.

Unit 5 Reliability Centered Maintenance (RCM): Concept, methodology, benefits; Total Productive Maintenance: Evolution of TPM, TPM objectives, concept, pillars of TPM. Failure Modes and Effects Analysis (FMEA)/ Failure Modes, Effects and Criticality Analysis (FMECA): Overview, elements of FMECA, applications and benefits, risk evaluation, risk priority numbers, criticality analysis, process FMEA, qualitative and quantitative approach to FMECA; design FMEA and steps for carrying out design FMEA.

Text Books

1. Ebeling CE; An Introduction To Reliability & Maintainability Engg; TMH
2. Srinath L.S; Reliability Engineering; East West Press.
3. Naikan; Reliability engg and life testing; PHI
4. Kapur KC and Lamberson LR; Reliability in Engineering Design; Wiley India

References Books:

1. Maintenance Engineering by S. K. Shrivastava
2. Reliability & Maintenance Engineering by N.V.S. Raju.

Course Outcomes (CO's):

After completion of this course the students shall be able to:

CO1 Have understood the concept of Reliability Engineering.

CO2 Have understood the concept of MTTR, MTBF, MTTF.

CO3 Have understood the concept of design-out maintenance, productive maintenance, shutdown maintenance and scheduled maintenance.

CO4 Have understood the concept of CBM and condition based monitoring techniques

CO5 Have understood the concept of RCM, TPM, FMEA and application of these concepts in organizations.

SEMESTER – VI

Sr. No.	Course Code	Course Name	L	T	P	Credits
1	RA3CO33	Robot System Design and SLAM (Simultaneous Localization and Area Mapping)	3	0	2	4
2	RA3CO38	Microcontroller and Programmable Logic Controllers	3	0	2	4
3	RA3CO46	Computer Vision	3	0	2	4
4	RA3ELXX	Program Elective - III	3	0	0	3
5	RA3ELXX	Program Elective - IV	3	0	0	3
6	OE000XX	Open Elective -II	3	0	0	3
7	RA3PC11	Mini Project	0	0	4	2
8	EN3NG08	Soft Skills -IV	2	0	0	2
		Total	**20**	**0**	**10**	**25**
		Total Contact Hours	**30**			

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO33	Robot System Design and SLAM (Simultaneous Localization and Area Mapping)	3	0	2	4

COURSE LEARNING OBJECTIVES (CLO's)

CLO 01 Understand the diverse applications and use cases of the Robotic Operating System (ROS) in complex real-world scenarios.

CLO 02 Apply simulation and visualization tools such as turtlesim, Gazebo, MoveIt, and Rviz to develop and test robotic systems.

CLO 03 Understand the fundamental concepts and principles of robot navigation and their implementation in robotics.

CLO 04 Analyse hardware interfacing challenges and develop solutions to effectively integrate ROS with robotic hardware.

CLO 05 Create and **test** robotic applications using ROS to address specific challenges and optimize performance.

UNIT I INTRODUCTION

Industrial Applications of Robots, Industrial Environments and Constraints, Free Open Source Software for Robot Simulation, Robotic Operating System (ROS), Gazebo, MoveIt, Ubuntu, Python, Installing and Configuring Simulation Softwares.

UNIT II ROBOTIC OPERATING SYSTEM

Robotic Operating System (ROS) Fundamentals, Building a ROS Application, ROS Services, ROS Actions, Unified Robot Description Format (URDF).

UNIT III ROBOT NAVIGATION

Slam: Simultaneous Localization and Mapping (SLAM) implementation with ROS2 packages and C++. Combining mapping algorithms with the localization concepts, Introduction to the Mapping and SLAM concepts and algorithms. Occupancy Grid Mapping, Mapping an environment with the Occupancy Grid Mapping algorithm, Grid-based Fast SLAM: Simultaneous mapping an environment and localize a robot relative to the map with the Grid-based Fast SLAM algorithm, Self-Localization, Path Planning and Obstacle Avoidance, Map-Building and Map Interpretation, Simultaneous Localization and Mapping, Navigation using Software Tools.

UNIT IV MANIPULATION

Object Manipulation, Manipulation Planning Algorithms, Prehension, Manipulation using Software Tools.

UNIT V ROBOT VISION

Object Detection; Pose Estimation, Logical Camera, ROS Tools for Vision.

TEXT BOOKS:

1. Morgan Quigley, “Programming Robots with ROS: A Practical Introduction to the Robot Operating System”, O'Reilly Media, 2015.
2. Carol Fairchild, Dr. Thomas L. Harman, “ROS Robotics by Example”, Packt, 2016.

AICTE Model Curriculum for UG Degree Course in Robotics & Artificial Intelligence Engineering 187

REFERENCE BOOKS:

1. Anis Koubaa, “Robot Operating System”, Springer link, 2016.
2. Anil Mahtani, “Effective Robotics Programming with ROS”, Packt Publishing, 2016.
3. Ramkumar Gandhinathan , Lentin Joseph , “ ROS Robotics Projects: Build and control robots powered by the Robot Operating System, machine learning, and virtual reality”, Packt Publishing Limited, December 2019.
4. SLAM for dummies: https://dspace.mit.edu/bitstream/handle/1721.1/119149/16-412jspring-2005/contents/projects/1aslam_blas_repo.pdf.

LIST OF EXPERIMENTS:

1. To install ROS and set-up a ROS workspace on a computer.
2. To write ROS talker-listener code in python.
3. To create a mobile robot base URDF model.
4. To create a 3-DOF robot arm URDF model.
5. To simulate a mobile robot base in Gazebo.
6. To attach the robot arm to base and simulate the complete mobile robot in Gazebo.
7. To create an environment in Gazebo for simulating a mobile robot for an industrial application.
8. To implement SLAM for industrial application using ROS open-source packages.
9. To configure and interface a webcam with ROS.
10. To use OpenCV with ROS for a vision application.

COURSE OUTCOMES (CO'S):

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

CO 01 Understand the core features and applications of the Robotic Operating System (ROS) and associated software tools.

CO 02 Apply simulation tools to create and configure a robot manipulator and its operational environment.

CO 03 Implement navigation algorithms and object manipulation techniques to achieve specific tasks in robotic applications.

CO 04 Incorporate and **apply** robot vision systems to enhance the functionality and performance of robots in real-world scenarios.

CO 05 Analyse the integration process between ROS and robotic hardware, and **evaluate** strategies to optimize performance and functionality.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO38	Microcontroller and Programmable Logic Controllers	3	0	2	4

COURSE LEARNING OBJECTIVES (CLOs)

CLO 01 Understand the fundamental distinctions between microcontrollers and microprocessors, including their applications and functionalities.

CLO 02 To familiarize with the basic architecture of 8051 microcontrollers.

CLO 03 Apply programming techniques in Assembly and C languages to develop and test software for the 8051 microcontrollers.

CLO 04 Understand the architecture, operation, and functionalities of Programmable Logic Controllers (PLCs) and their applications in automation.

CLO 05 Create and **implement** control systems using PLCs to address specific automation tasks and improve system efficiency.

UNIT I INTRODUCTION TO MICROCONTROLLER

Evolution of microprocessor and microcontroller, microcontroller family. The 8051 microcontroller features, architecture of 8051, block diagram. Memory organization, Program memory, data memory, internal and external memory, Internal DATA memory structure register banks, bit addressable area, scratch pad area stock area, memory addresses, special function registers, accumulator, B register, DPTR, SP, Program Status Word, Flags other SFRs, selection of register bank, Internal programme memory, capacity address range, provision for external data memory, address range, provision for external programme memory, address range, external memory access, use of address latch. Pin configuration of 8051 description of eh pins, Ports in 8051, port addresses, making ports as input and output ports, timers and counters in 805, timer registers, TMOD register, TCON register, different modes.Frequency of internal clock signal, machine cycle, calculation of time delay. Interrupts in 8051, need IE register IP Register, interrupt vector table.

UNIT II: PROGRAMMING AND APPLICATION OF MICROCONTROLLER

Programming and application of microcontroller, the 8051 instruction set, classification, data transfer instructions, arithmetic instructions-logical instructions, branching and control transfer instructions, use of each instruction. Arithmetic and logical operations, Subroutines interrupt service routine-need of subprograms-calling a subprogram, ACALL, LCALL examples. Data transfer in 8051-addressing modes. Simple Programmes, arithmetic operations-block transfer of data - array sorting-time delay using subroutines.

UNIT III: ADVANCED MICROCONTROLLERS & INTERFACING.

Serial communication, basic principles, baud rate, asynchronous and synchronous communication, data framing-8051 registers related to serial communication, SBUF,SCON serial communication ports. Microcontroller based system, peripherals interfacing peripherals 8255 programmable peripheral interface, need-block diagram, control word Register Interfacing of stepper motor and relays.

UNIT IV: COMPARISON OF VARIOUS MICROCONTROLLERS.

Features of PIC 18, block diagram, block diagram of PIC 16, architecture. Features of AVR 25 block diagram of AT tiny 25, block diagram of AT mega 32, AVR architecture.

UNIT V: PROGRAMMABLE LOGIC CONTROLLERS.

PLC- Applications, Importance, classification, Comparison of PLC with Relay panel, block diagram and Operation of PLC, Classification of PLC programming, Ladder programming. Types of Instructions bit instructions, timer/counter instructions, Logical, compare instructions, move instructions math instructions, programme control instructions, simple ladder programs connecting the above Instructions, motor control using PLC.

TEXT BOOKS

1. Mazidi Muhammad Ali. The 8051 Microcontroller and Embedded Systems: Using Assembly and C: Pearson Education.
2. Muhammed Ali Mazeedi, Rolin D McKinlay & Danny Causey. PIC Microcontroller and Embedded Systems: Using Assembly and C Pearson Prentice Hall.

REFERENCE BOOKS

1. Muhammed Ali Mazeedi . AVR Microcontroller and Embedded Systems: Pearson Education Ltd.
2. Kenneth J. Ayala. The 8051 Microcontroller: Thomson Delmer Learning.

LIST OF EXPERIMENTS:

1. Addition of two 8/16-bit numbers (Using Registers & Memory)
2. Subtraction of two 8-bit numbers. (Using Registers & Memory)
3. Multiplication of two 8-bit numbers using MUL instruction.
4. Multiplication of two 8-bit numbers without using MUL instruction (Counter method)

5. Division of two 8-bit numbers using DIV instruction.
6. Division of two 8-bit numbers without using DIV instruction (Counter method)
7. ALP to find the Pi value up to 5 decimal places
8. ALP to transfer block of data from one memory locations to another memory Locations.
9. ALP to sum of first 'n' natural numbers.
10. To find the Largest number in a given array of numbers
11. To find the smallest number in a given array of numbers.
12. Arrange 'n' numbers in Ascending order
13. Arrange 'n' numbers in Descending order
14. C- Program to store the data in the accumulator
15. Write a program to load three numbers into Accumulator and send them to port 1
16. Write a program to send hex values for ASCII characters of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D and E to port P1
17. Program to send values 00-ff to Port 1
18. Program to toggle bits of P1 with time delay, Program to read a byte from P1, wait 1/2 second and then send to P2.
19. Write a C program for 8051 to transfer the letter "A" serially at 9600 baud continuously. Use 8-bit data and 1 stop bit.
20. Write an 8051 C program to transfer the message "SJC" serially at 9600 baud, 8-bit data, 1 stop bit. Do this continuously.
21. Write an 8051 C Program to send the two messages "first name" and "last name" to the serial port. If SW = 0, send first name else if SW = 1, send last name. Set the baud rate at 9600, 8- bit data, and 1 stop bit
22. Program the 8051 in C to receive bytes of data serially and put them in P1. Set the baud rate at 9600, 8-bit data, and 1 stop bit.

COURSE OUTCOMES (COs):

CO 01 To understand the architecture of microcontroller 8051.

CO 02 To understand the counter & timers.

CO 03 To understand the programming of microcontroller 8051

CO 04 To understand the features of PIC and AVR.

CO 05 To apply the interfacing of PLC

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3CO39	Computer Vision	3	0	2	4

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO 01Understand the basic principles of image formation, image processing algorithms and recognition from single or multiple images (video).

CLO 02Knowledge of core vision tasks of scene understanding and recognition.

CLO 03 Applications to object recognition, image analysis, image retrieval and object tracking will be discussed.

UNIT I OVERVIEW OF COMPUTER VISION AND IMAGE PROCESSING

Image Formation and Representation: Imaging geometry, radiometry, digitization, cameras and Projections, rigid and affine transformation, Pixel transforms, color transforms, histogram processing, histogram equalization, filtering, convolution, Fourier transformation and its applications in sharpening, blurring and noise removal.

UNIT II FEATURE DETECTION AND SEGMENTATION

Edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors, Morphological operations, Active contours, split & merge, watershed, region splitting, region merging, graph-based segmentation, mean shift and model finding, Normalized cut.

UNIT III CAMERA CALIBRATION

Camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.

UNIT IV MOTION REPRESENTATION AND MOTION TRACKING

The motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation statistical filtering; iterated estimation; observability and linear systems; the Kalman filter.

UNIT V OBJECT RECOGNITION

Alignment, appearance-based methods, invariants, image eigenspaces, applications of object recognition.

TEXT BOOKS:

Milan Sonka,VaclavHlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" 3rd Edition, Cengage Learning, 2008.

E. Trucco and A. Verri, Introductory techniques for 3D computer vision, Prentice Hall, 1998.

REFERENCE BOOKS:

Digital Image Processing using MATLAB, By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2010

Robert Haralick and Linda Shapiro, Computer and Robot Vision, Vol. I, II, Addison-Wesley, 1993.

Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.

Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

LIST OF EXPERIMENTS:

Implementing various basic image processing operations in python/matlab/open-CV:

Reading image, writing image, conversion of images, and complement of an image

Implement contrast adjustment of an image. Implement Histogram processing and equalization.

Implement the various low pass and high pass filtering mechanisms.

Use of Fourier transform for filtering the image.

Utilization of SIFT and HOG features for image analysis.

Performing/Implementing image segmentation

Implement optical flow computation algorithm.

Demonstrate the use of optical flow in any image processing application

Object detection and Recognition on available online image datasets

Character or digit or face classification project.

COURSE OUTCOMES:

After the completion of this subject students will be able to:

CO 01 Learn fundamentals of computer vision and its applications

CO 02 Understand the basic image processing operations to enhance, segment the images.

CO 03 Understand the analyzing and extraction of relevant features of the concerned domain problem.

CO 04 Understand and apply the motion concepts and its relevance in real time applications

CO 05 Apply the knowledge in solving high level vision problems like object recognition, image classification etc.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
RA3EL07	Artificial Intelligence	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO 01 Learn the basic AI approaches and design and implement search strategies

CLO 02Represent knowledge

CLO 03Perform logical and probabilistic reasoning

CLO 04Understand game playing techniques

CLO 05 Understand various type of learning

UNIT I INTRODUCTION

Meaning and definition of artificial intelligence, various types of production systems, Characteristics of production systems, Study and comparison of breadth first search and depth first search. Techniques, other Search Techniques like hill Climbing, Best first Search. A* algorithm, AO* algorithms etc, and various types of control strategies.

UNIT II KNOWLEDGE REPRESENTATION

Knowledge Representation, Problems in representing knowledge, knowledge representation using propositional and predicate logic, comparison of propositional and predicate logic, Resolution, refutation, deduction, theorem proving, inferencing, monotonic and nonmonotonic reasoning.

UNIT IIIPROBABILISTIC REASONING

Probabilistic reasoning, Bayes theorem, semantic networks scripts schemas, frames, conceptual dependency, fuzzy logic, forward and backward reasoning.

UNIT IVGAME TECHNIQUES

Game playing techniques like minimax procedure, alpha-beta cut-offs etc, planning, Study of the block world problem in robotics, Introduction to understanding and natural languages processing.

UNIT VNEURAL NETWORKS

Introduction to learning, Various techniques used in learning, introduction to neural networks, applications of neural networks, common sense, reasoning, some example of expert systems.

TEXT BOOKS:

1. Rich E and Knight K, Artificial Intelligence, TMH, New Delhi.

2. Nelsson N.J., Principles of Artificial Intelligence, Springer Verlag, Berlin.

REFERENCE BOOKS:

1. Waterman D.A., A guide to Expert System, Addison Wesley, Reading (Mars).

2. Giarratand & Riley, Expert Systems: Principles and Programming, Thomson.

COURSE OUTCOMES (COs):

After the completion of this subject students will be able to:

CO 01 Explain different types of searching techniques

CO 02 Represent knowledge

CO 03 Apply logical reasoning

CO 04 Apply game playing and CSP techniques

CO 05 Explain various types of learning

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL10	Industrial Robotics and Material Handling Systems	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 To understand the basics of manipulators and types of industrial robots.

CLO02 To know about the various drive systems for robot, sensors and their applications

CLO03 To know the various industrial applications of robots.

CLO04 To understand the design and force analysis of the end-effector.

CLO05 To understand the industrial material handling systems.

UNIT I INTRODUCTION

Robotic arm components and working, types of industrial robots, load handling capacity, general considerations in robotic material handling, material transfer, machine loading and unloading, robot centered cell.

UNIT II ROBOTIC VISION

Robotic vision systems, image processing and analysis, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

UNIT III INDUSTRIAL APPLICATIONS

Important applications of robots in various sectors, Factors influencing the selection of a robot, robot performance testing, economics of robotisation, application of robots in continuous arc welding, spot welding, spray painting, assembly operation, cleaning, robot for underwater applications, impact of robot on industry and society.

UNIT-IV END EFFECTORS

Types of end effectors, Mechanical grippers, other types of gripper, active and passive grippers, tools as end effector, the robot/end effector interface, considerations in gripper selection and design, Gripper force analysis, design of multiple degrees of freedom,

UNIT-V MATERIAL HANDLING

Concepts of material handling, principles and considerations in material handling systems design, advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems, barcode technology, radio frequency identification technology.

TEXT-BOOKS

Mikell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, John Wiley & sons

2. Ramachandran Nagarajan, Introduction to industrial robotics, Pearson

3. S. K. Saha, Introduction to Robotics, McGraw Hill Education

REFERENCE BOOKS

Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, “Robotic Engineering-An integrated Approach” Prentice Hall India,

Mikell P. Groover, Industrial Robotics, Tata McGraw Hill India

COURSE OUTCOMES (COs)

After the completion of this course the students shall be able to:

CO01 Understand the working of industrial robots.

CO02 Apply suitable principles and controls in designing automatic manufacturing cells

CO03 Compare and select an appropriate robot for industrial applications.

CO04 Analyze and select suitable end effector.

CO05 Identify appropriate material handling systems.

PROGRAM ELECTIVES – III

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL24	Smart Sensors	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 To understand the operation of different types of sensors and microsystems.

CLO02 To design sensors with appropriate electronic interfaces as a complete system.

CLO03 Discuss how sensors enable data collection and automation in IoT applications

CLO04 Evaluate the trade-offs in choosing specific sensor technologies for different applications.

UNIT I INTRODUCTION

Definition and Classification of Sensors- Self-calibration, Self-testing & self-communicating, Selection criteria for sensing technologies, Sensor Components, Communication interfaces, Architecture of Smart Sensors, Integration with microcontrollers and microprocessors, Importance of sensors in modern technology, Advantages and disadvantages of smart sensors, Sensing Technologies, Overview of different sensing technologies (e.g., chemical, optical, thermal),

UNIT II TYPES OF SENSORS

Acoustic Sensors, Mechanical Sensors, Piezoelectric sensors and materials, Saw sensors, Integrated Hall sensors, Magnetic sensors, Magneto-transistors, other magnetics transistors and future trends, Radiation Sensors, Thermal Sensors and Chemical Sensors, Radiation basics - HgCdTe infrared sensors, Visible-light color sensors - high-energy photodiodes, Interaction of gaseous species at semiconductor Surfaces - Catalysis - the acceleration of chemical reactions - Thin-film sensors - FET devices for gas and ion sensing.

UNIT III MEMS FABRICATION

Micro-and Nanotechnologies or Sensors - Fundamentals of MEMS fabrication, introduction and description of basic processes, MEMS fabrication technologies, bulk micromachining, Surface micromachining, High- aspect-ratio (LIGA and LIGA-Like) technology microfluidics microsystem components, Microfluidics microsystem components, Nanotechnology - product prospects - application trends Procedures and techniques, the making of ultrathin films Creation of lateral

nanostructures - clusters and Nano crystalline materials and principles of self-organization and Future trends.

UNIT IV IoT INTEGRATION

IoT Basics, Introduction to IoT and its components, Role of sensors in IoT, Integration of Smart Sensors with IoT, Communication protocols (e.g., MQTT, CoAP), Cloud computing for data storage and analysis

UNIT V SENSOR FABRICATION

Fabrication of Sensor and Smart Sensor, Integration of Micromachining and Microelectronics, Wafer bonding, Standard of Smart Sensor Network, Communication for smart sensors, Role of smart sensors in environmental monitoring, smart grids, battlefield reconnaissance, exploration, Industrial applications of smart sensors, emerging technologies in sensor development, challenges and opportunities in smart sensor implementation

TEXT BOOKS:

Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer; 4th ed. 2010.

S. M. Sze, “Semiconductor Sensors”, Wiley-Interscience, 1994.

REFERENCES:

Gerard Meijer, “Smart sensor systems”, Wiley, 2008.

W Gopel, J. Hesse, J. N. Zemel, “Sensors A Comprehensive Survey”, Vol. 9, Wiley-VCH, 1995.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO01 Understand the operation of different types of sensors and microsystems.

CO02 Design the sensors with appropriate electronic interface as a complete system.

CO03 Analyze and apply sensors in robotics and automation.

CO04 Design and fabricate the process of MEMS fabrication.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL39	UAV Networks	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 Understand the UAV types and their missions for swarm communication.

CLO02 To familiarize the basics of data link communication for UAV.

CLO03 To explore the network platforms for UAV based systems.

CLO04 To enable students to analyze the security issues and challenges in UAV Networks.

UNIT I INTRODUCTION

Introduction – UAV Types and Missions – Swarming and Miniaturization- Air to Ground and Air to air data link communication – Air to ground communication for manned aviation – Practical and UAV and MUAV links – Terrestrial wideband solutions.

UNIT II NETWORKING

Aerial WiFi Networks – Characteristics- Communication demands –requirements – Airborne Networks and protocols – Aeronautical protocol architecture – UAV platform systems and UAV Networked systems.

UNIT III SAFETY SYSTEMS

UAV detection and identification – Cellular connected UAVs – Safety security and privacy in UAV.

UNIT IV CONTROL SYSTEMS

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-troubleshooting.

UNIT V NAVIGATION

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing- Future Prospects and Challenges-Case Studies – Mini and Micro UAVs

TEXT BOOKS:

Jae H. Kim, UAV Networks and Communications, Cambridge University Press, 2018.

UAV Communications for 5G and beyond, Wiley, 2020.

Unmanned Aerial Vehicles for Internet of Things (IoT) Concepts, Techniques, and Applications, Wiley, 2021.

REFERENCES:

Hailong Huang, Andrey V. Savkin, Chao Huang, Wireless Communication Networks Supported by Autonomous

UAVs and Mobile Ground Robots, Elsevier Science, 2022.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO01 Summarize the types of UAV and their missions for swarm communication.

CO02 Describe the basics of data link communication for different interfacing of UAV.

CO03 Enumerate the types of network platforms for UAV based systems.

CO04 Analyze about the security and privacy issues in UAV Networks

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL26	Neural Networks	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 The fundamental concepts of Neural Networks

CLO02 To familiarize with artificial learning processes.

CLO03 To introduce different neural network architectures and selection process.

UNIT I INTRODUCTION TO NEURAL NETWORK SYSTEM

Introduction to Neural Network System: Introduction to biological neurons and their artificial

models, history of artificial neural systems development, Simple Memory and Restoration of Patterns, basic concepts related to neural networks: three layers of neural network systems, units, connections, site, mode, perceptron, single layer and multiple layer perceptron, McCulloch-Pitts Neuron Model, Neuron Modelling for Artificial Neural System, Models of neural networks: feedforward and feedback networks, neural processing.

UNIT II NEURAL NETWORK LEARNING AND ADAPTATION

Neural Network Learning and Adaptation: Introduction to neural network learning and adaptation, learning as approximation or Equilibria Encoding, concepts of supervised and unsupervised learning, neural network learning rules: Hebbian learning rule, perceptron learning rule, delta learning rule, Widrow-Hoff Learning Rule, correlation learning rule, Winner- Take-All learning rule, Outstar learning rule, summary and comparison of artificial

neural network learning rules.

UNIT III CLASSIFICATION MODEL

Single Layer Perceptron Classifiers: Introduction to single layer perceptron, classification model, features and decision tree, discriminant functions, linear machine and minimum distance classification, non-parametric training concepts, training and classification using the

discrete perceptron, single layer continuous perceptron neural networks for linearly separable classification, multi category single layer perceptron neural networks.

UNIT IV MULTILAYER FEED FORWARD NETWORKS

Multilayer feed forward Neural Networks: Introduction to multilayer perceptron neural networks, linearly non separable pattern classification, delta learning rule for multilayer perceptron networks, generalized delta learning rule, Feedforward recall and error Back- Propagation training, training errors, Multilayer Feed forward Networks as Universal Approximators, Learning Factors: Initial Weights, cumulative weight adjustments vs incremental updating, learning constant and momentum method, classifying and expert layered networks, Character Recognition Application, expert systems applications, learning time sequences.

UNIT V FEEDBACK NEURAL NETWORKS

Single-Layer Feedback Neural Networks: Introduction to single layer feedback neural networks, basic concepts of dynamic systems, Mathematical Foundations of Discrete-Time and gradient type Hopfield Networks, Transient Response of Continuous-Time Networks, Relaxation Modelling in Single-Layer Feedback Networks, Summing Network with Digital

Outputs, Minimization of the Traveling Salesman Tour Length.

TEXT BOOK:

Introduction to Artificial Neural Systems – Jacek M Zurada, West Publishing Company.

An introduction to neural networks - Kevin Gurney, UCL Press.

REFERENCE:

Principles of Artificial Neural Networks, 2 nd Edition - Daniel Graupe, World Scientific Publishing Co. Pte. Ltd.

LIST OF EXPERIMENTS:

1. Design and train perceptron for identifying ODD and EVEN number.

2. Write a program to Implement McCulloch-pitts model of Neuron:

- Design and train a perceptron for AND gate?
- Design and train a perceptron for OR gate?

- Design and train a perceptron for EX-OR gate?
- Design and train a perceptron for NOR gate?

3. Create a bidirectional Associative memory (BAM) for ID and telephone number.

4. Design and train the Hopfield net to map the input vector with the stored vector and correct them.

5. Write a program for back propagation algorithm.

6. Write a program to implement Delta rule.

7. Write a program of perceptron training algorithm.

8. Write a program to test and train a dataset (dataset can be anything: eg: wine dataset).

9. Write a program for Error back propagation Algorithm.

10. Write a program to implement Hebb's rule (unsupervised learning algorithm).

COURSE OUTCOMES (COS):

After completion of this course the students shall be able to:

CO01 Understand the algorithms for multilayer perceptrons and radial basis function networks

CO02 Select the appropriate architecture for a given problem

CO03 Understand deep learning networks through convolutional networks and its applications

CO04 Apply neural networks to classification and recognition problems.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL27	Machine to Machine Communications	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 To introduce the evolution of Machine-to-Machine communications and their standards.

CLO02 To summarize the architecture and protocols for Machine-to-Machine communication.

CLO03 To illustrate the applications of Machine-to-Machine communications in different cases.

CLO04 To establish the communication between two machines with suitable protocols.

UNIT I INTRODUCTION

Introduction- Services and protocols –Edge and core – OSI and TCP/IP models – Overview of ETSI and 3GPP architecture– M2M communication Technologies -Cellular technology- satellite communication

UNIT II SHORT RANGE TECHNOLOGIES

Short range Technologies- LPWAN Technology- GPS/GNSS and positioning technology- Vehicle telemetry services – Smart meters – Smart asset tracking –Supply chain management solutions

UNIT III WEARABLE TECHNOLOGIES

Wearable technologies – Internet protocol stack – Ipv6 and IoT- Application protocols –CoAP-MQTT – LoRA WAN -M2M communication in constrained devices – Gateway- PAN- WSN- SUN-Routing protocols- CoRE- Basics of V2x - Security in M2M.

UNIT IV MODULATION SCHEMES

Modulation Schemes for MMW communications- PSK - OFDM. MMW Transceiver architecture-MMW Antennas- Path Loss and Antenna Directivity - Antenna Beam width - Beam steering Antenna- Need for MIMO – Channel Capacity of SISO and MIMO Systems.

UNIT V APPLICATIONS IN COMMUNICATION SYSTEMS

Applications in communication systems – Signal Detection – Channel Encoding and Decoding – Channel estimation, Prediction and Compression – End – to – End communication – Resource allocation.

TEXT BOOKS:

Veena S. Chakravarthi, Internet of Things and M2M Communication Technologies Architecture and Practical

Design Approach to IoT in Industry 4.0, Springer International Publishing, 2021.

Machine-to-machine (M2M) Communications Architecture, Performance and Applications, Elsevier Science, 2014

REFERENCES:

M2M Communications A Systems Approach, Wiley, 2012.

Machine-to-Machine Communications Architectures, Technology, Standards, and Applications, Taylor & Francis, 2014.

Cellular V2X for Connected Automated Driving, Wiley, 2021.

LIST OF EXPERIMENTS:

Lab Component (with Arduino / Rpi)

Serial communication for machine control

Wireless Interface through Bluetooth/wifi

Wireless control of wheeled robot using Bluetooth/wifi,

M2M communication MQTT and LoRA

Visualization of diverse sensor data using dashboard through Thing Speak

Android app development using MIT inventor for M2M.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO01 Understand the Machine-to-Machine communications and their standards.

CO02 Discuss the architecture and protocols for Machine-to-Machine communication.

CO03 Demonstrate the applications of Machine-to-Machine communications in different cases.

CO04 Experiment the communication between two machines with suitable protocols.

PROGRAM ELECTIVES – IV

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL40	Intelligent Manufacturing Systems	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 To provide fundamental concepts on intelligent manufacturing system (IMS) to achieve flexible, smart, and reconfigurable manufacturing processes.

CLO02 To familiarize various supporting technologies required to implement IMS.

UNIT I INTRODUCTION

Introduction to Manufacturing systems, various subsystems in manufacturing systems, procurement, design, manufacturing, inspections, assembly, prototyping, material handling, storage systems, concept of Intelligent manufacturing.

UNIT II INTERNET OF THINGS ENABLED MANUFACTURING

Internet of Things enabled manufacturing, cloud manufacturing. Characteristics of Intelligent manufacturing systems: Intelligent decision making, Application of Artificial Intelligence and Machine learning in developing intelligent manufacturing systems.

UNIT III DEVELOPMENT OF INTELLIGENT SYSTEMS

Components of Intelligent Manufacturing Technologies, Development of Intelligent systems for Design, Process planning, Controls, Scheduling, Quality Management, Maintenance and Diagnostics.

UNIT IV SUPPORTING TECHNOLOGIES

Supporting technologies for IMS: Industry Internet of Things, Cyber Physical Systems, Cloud computing, RFID Technologies, Data Analytics, other Information and Communications Technology.

UNIT V FRAMEWORK FOR INTELLIGENT MANUFACTURING

Framework for intelligent manufacturing: Smart design, Smart machines, Smart control, Smart scheduling, Human-Machine collaboration, collaborative robots and other enabling technologies such as AR and VR, Data Driven intelligent manufacturing models, Autonomous intelligent manufacturing units. Applications and case studies in intelligent manufacturing systems implementation, limitation of technologies and other real time issues in implementations of IMS.

TEXT BOOKS:

Andrew Kusiak, Intelligent Manufacturing Systems, Prentice Hall international series- industrial & systems engineering, 1990.

Intelligent Manufacturing in the Context of Industry 4.0: A Review, Engineering, Elsevier Publications, Volume 3, Issue 5, October 2017, Pages 616-630.

Peigen Li, Special Issue: Intelligent Manufacturing, Engineering, Elsevier Publications, 3, 2017, 575.

REFERENCES:

Yubao Chen, Integrated and Intelligent Manufacturing: Perspectives and Enablers, Engineering, Engineering 3, 2017, Pages 588–595.

Hamid R. Parsaei and Mohammad Jamshidi, Design and Implementation of Intelligent Manufacturing Systems: From Expert Systems, Neural Networks, to Fuzzy Logic, Prentice Hall Series Publication, 1995.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO01 Explain the various concepts of intelligent manufacturing systems.

CO02 Elaborate the various components features and its integration for IMS.

CO03 Choose suitable supporting technologies to enable IMS implementation.

CO04 Discuss the real time issues in implementations of IMS with suitable case studies.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL29	Industry 4.0	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 To familiarize with insight and understanding of the 4th industrial revolution and its impact on the industry.

CLO02 To impart the basic knowledge on the drivers, enablers, and design principles of Industry 4.0.

UNIT I INTRODUCTION TO INDUSTRY 4.0:

The various industrial revolutions, digitalization and the networked economy, drivers, enablers, comparison of industry 4.0 factory and today's factory, trends of industrial big data and predictive analytics for smart business transformation.

UNIT II ROAD TO INDUSTRY 4.0:

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Big data, Value chains in Manufacturing companies, Smart factories, Smart Devices and Products, Smart Logistics, Smart Cities, smart services, Predictive Analytics, Case studies.

UNIT III TECHNOLOGIES FOR ENABLING INDUSTRY 4.0

Cyber Physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Cyber Security, Augmented / Virtual reality, Artificial Intelligence, System integration, digital twin, 3D printing, Case studies.

UNIT IV INDUSTRY 4.0 DESIGN PRINCIPLES:

Introduction to Industry 4.0 design principles – Interoperability, Communication systems and standards for Industry 4.0, virtualization, Decentralization, Modularity, real time capability, information transparency – Foundation of Industry 4.0 - Cloud Manufacturing and the connected factories.

UNIT V IMPACT OF INDUSTRY 4.0:

Impact of Industry 4.0 on – service and business models, IT security, manufacturing, machine safety, product life cycle, socio economic factors, textile industries, healthcare industries, real estate industries, maritime industries, tourism industries - Compelling Forces and Challenges in implementing Industry 4.0. Case studies.

TEXT BOOKS:

Klaus Schwab, “The Fourth Industrial Revolution”, Portfolio Penguin, 2017.

Bruno S.Sergi, Elena G.Popkova, Aleksei V. Bogoviz and Tatiana N. Litvinova, Understanding Industry 4.0.

AI, The internet of things, and the future of work”, Emerald publishing limited, 2019.

REFERENCES:

Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2016.

Kaushik kumar, DivyaZindani, J. Paulo Davim, “Digital manufacturing and assembly systems in Industry 4.0”,CRC Press, Taylor and Francis group, 2020.

Antonio sartal, Diego Carou, J.PauloDavim, “ Enabling technologies for the successful deployment of Industry 4.0, CRC press, 2020.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO01 Describe the concepts and characteristics of Industry 4.0.

CO02 List and comprehend the different enabling technologies and its role in Industry 4.0.

CO03 Enumerate different design principles of Industry 4.0.

CO04 Understand and describe the impact of Industry 4.0 in different sectors with case studies.

CO05 Evaluate the opportunities and the challenges brought through Industry 4.0.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL30	Micro and Nano Electromechanical Systems	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 The concepts of micro and nano electromechanical devices.

CLO02 Understand the fabrication process of Microsystems.

CLO03 To provide information on various nanofabrication techniques currently in practice.

UNIT I INTRODUCTION

Introduction, overview and applications of Micro Electro Mechanical Systems (MEMS) and Nano Electro Mechanical Systems (NEMS). Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals. Mechanical components in MEMS.

UNIT II PRINCIPLES OF MICROSYSTEMS

Design concepts of mechanical components. Working Principles of Microsystems. Engineering Science for Microsystems design and Fabrication. Scaling laws – Scaling in geometry, rigid body dynamics.

UNIT III FABRICATION TECHNOLOGIES

Fabrication technologies – Photolithography – Ion implantation – diffusion – oxidation – CVD – Physical Vapor Deposition – Etching. Micro manufacturing – Bulk and surface micromachining – LIGA. Applications of Microsensors and Microactuators for MEMS, Microsystems Design – Design considerations – Process design – Mechanical Design – CAD – Micro system packaging – Levels – Bonding – Interfaces – Assembly.

UNIT IV NANO ELECTRO MECHANICAL SYSTEMS

Nano Electro Mechanical Systems (NEMS) Introduction- Nano machining of NEMS based lithography techniques, Nano electromechanical systems fabrication, nano imprint lithography, polymeric nanofiber templates, focused ion beam doping and wet chemical etching, stencil lithography and sacrificial etching.

UNIT V SCANNING-PROBE TECHNIQUES

Scanning-probe techniques, Self-assembly for NEMS, nanometrology and applications of nano sensors for NEMS- ZnO nanorods based NEMS device: Gas sensor, future challenges.

TEXT BOOKS:

Tai–Ran Hsu,'Mems & Microsystems Design and Manufacturing', John Wiley & Sons, 2008, 2nd Edition.

Sergey Edward Lyshevski, MEMS and NEMS: Systems, Devices, and Structures‖ CRC Press, 2002.

REFERENCE:

S.A. Campbell: The Science and Engineering of Microelectronic Fabrication, Oxford Univ. Press, New York 2001.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO01 Interpret the basics of micro/nano electromechanical systems

CO02 Identify and describe micro fabrication techniques based on the materials and applications.

CO03 Application of micro/nano sensors and actuators in development of MEMS/NEMS.

CO04 Choose appropriate nano fabrication process based on various principles

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL41	Digital Twin and Industry 5.0	3	0	0	3

COURSE LEARNING OBJECTIVES (CLOS)

In this course students will learn:

CLO01 To understand the basics concepts in digital twin

CLO02 To Introduce the concepts in digital twin in a discrete Industry

CLO03 To Introduce the concepts in digital twin in a process Industry

CLO04 To obtain the knowledge in industry 5.0

CLO05 To know about the advantages in industry 5.0

UNIT I INTRODUCTION

Digital twin – Definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – control Parameters-Real time systems – control Parameters – Handshaking Through Internet – cyber physical systems.

UNIT II DISCRETE INDUSTRY

Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection & analysis for product & production improvements, Automation simulation, Digital Enterprise.

UNIT III PROCESS INDUSTRY

Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise.

UNIT IV INDUSTRY 5.0

Industrial Revolutions, Industry 5.0 – Definition, principles, Application of Industry 5.0 in process & discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways, Basics of Communication requirements – cognitive systems 5.0

UNIT V PRODUCT QUALITY

Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.

TEXT BOOKS:

Ang Liu, Tianliang Hu, A.Y.C. Nee, Digital Twin Driven Smart Design, Elsevier Science, 2020.

Fei Tao, Meng Zhang, A.Y.C. Nee, Digital Twin Driven Smart Manufacturing, Elsevier Science ,2019.

Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2018

REFERENCES:

Surjya Kanta Pal, Debasish Mishra, Arpan Pal, Samik Dutta, Debashish Chakravarty,

Digital Twin - Fundamental Concepts to Applications in Advanced Manufacturing, Springer International Publishing AG, 2021

Digital Twin Technology, CRC Press, 2021

Digital Twins Applications to the Design and Optimization of Bioprocesses, Springer International Publishing, 2021.

Uthayan Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2022.

COURSE OUTCOMES (COs):

After completion of this course the students shall be able to:

CO01 Analyze the basics concepts in digital twin

CO02 Recognize the concepts in digital twin in a discrete Industry

CO03 Recognize the concepts in digital twin in a process Industry

CO04 Obtain the knowledge in industry 5.0

CO05 Apply the advantages in industry 5.0 with various applications

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SEMESTER – VII

Sr. No.	Course Code	Course Name	L	T	P	Credits
1		Program Elective - V	3	0	0	3
2		Open Elective III	3	0	0	3
3	RA3PC12	Project-1	0	0	8	4
4	RA3PC03	Industrial Training	0	2	0	2
5	EN3NG06	Open Learning courses	1	0	0	1
		Total	**7**	**2**	**8**	**13**
		Total Contact Hours	**17**			

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL18	Autonomous Vehicle	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} To understand the hardware and software components of an autonomous vehicle

CLO_{02} To design and develop state estimation and localization techniques for an autonomous vehicle

CLO_{03} To design and develop convolutional neural networks for visual perception of an autonomous vehicle

Unit I

Introduction – Terminology, Design consideration, Safety assessment. Commonly used hardware, main components of software stack, Vehicle modelling and control, safety frameworks and current industry practices State Estimation and Localization – Least squares.

Unit II

Vehicle localization sensors – GPS and IMU – Extended Kalman filter, unscented Kalman filter – LIDAR scan matching, iterative Closest Point Algorithm – Multiple sensor fusion for vehicle state estimation and localization Feedforward neural networks.

Unit III

Review of Deep Learning, Multilayer Perceptron, Optimization, Stochastic Gradient Descent, Back propagation - Introduction to Convolutional Neural Networks(CNN): Architecture, Convolution/Pooling layers – Understanding and Visualizing CNN

Unit IV

Visual Perception – Visual Perception - Pinhole camera model, intrinsic and extrinsic camera calibration, monocular and stereo vision, projective geometry - CNNs for 2 D Object detection, Semantic segmentation, Motion Planning - Driving Missions, Scenarios, and Behavior,

Unit V

Motion Planning Constraints, Objective Functions for Autonomous Driving, Hierarchical Motion Planning - Occupancy Grids, Populating Occupancy Grids from LIDAR Scan Data, Occupancy Grid Updates, High-Definition Road Maps, Creating a Road Network Graph, Dijkstra's Shortest Path Search, A* Shortest Path Search, Motion Prediction, Map-Aware Motion Prediction, Time to Collision

Textbooks:

1. Lipson, H & Kurman, M, Driverless: Intelligent Cars on the Road Ahead, MIT Press, 2016

2. Dan Simon, “Optimal State Estimation: Kalman, H∞, and Nonlinear Approaches”, John Wiley & Sons, 2006

3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press 2016

4. Manoj Karkee and Qin Zhang Editors Fundamentals of Agricultural and Field Robotics, Springer (2021)

References:

1. Dan Zhang, Bin Wei, Robotics and Mechatronics for Agriculture, CRC Press (2017)

2. Andrey Ronzhin, Tien Ngo, Quyen Vu, Vinh Nguyen. Ground and Air Robotic Manipulation Systems in Agriculture Springer (2022)

3. K R Krishna, Push Button Agriculture Robotics, Drones, Satellite-Guided Soil and Crop Management, AAP (2016)

4. K.R. Krishna, Aerial Robotics in Agriculture Parafoils, Blimps, Aerostats, and Kites, AAP (2021)

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Understand hardware and software components in an autonomous vehicle

CO_{02} Develop state estimation and localization techniques for an autonomous vehicle

CO_{03} Build, compare and contrast feedforward neural networks

CO_{04} Build, compare and contrast convolutional neural networks for visual perception of an autonomous vehicle.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL32	Introduction to Big Data Analysis	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} To introduce the concepts of big data and algorithmic trading.

CLO_{02} To familiarize the concepts of NoSQL

CLO_{03} To provide information on **Hadoop**

CLO_{04} To familiarize the concepts of **MapReduce**

CLO_{05} To familiarize the concepts of Hbase data model

Unit I

What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics

Unit II

NoSQL - Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer-peer replication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing mapreduce calculations.

Unit III

Hadoop - Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFS concepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures.

Unit IV

MapReduce - MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy of MapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce and YARN, job scheduling, shuffle and sort, task execution, MapReduce types, input formats, output formats.

Unit V

Big data Analysis - Hbase, data model and implementations, Hbase clients, Hbase examples, praxis. Cassandra, Cassandra data model, Cassandra examples, Cassandra clients, Hadoop integration, Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

Text Books:

1 Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning, Raj kamal,

Preeti Saxena, McGraw Hill, 2019.

2 Big Data, Big Analytics: Emerging Business intelligence and Analytic trends for Today's

Business, Michael Minelli, Michelle Chambers, and AmbigaDhiraj, John Wiley & Sons,

2013

References:

1. Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013

2. Hadoop: The Definitive Guide, Tom White, Third Edition, O'Reilley, 2012.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To implement the concepts of big data and algorithmic trading.

CO_{02} To interpret the concepts of NoSQL

CO_{03} To implement the concepts of Hadoop

CO_{04} To analyze the concepts of MapReduce

CO_{05} To implement the concepts of HBase data model

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL29	Industry 4.0	3	0	0	3

Course Learning Objectives (CLOs):

CLO1: To comprehend the fundamental concepts and principles of Industrial revolution 4.0.

CLO2: To explore the integration of robotics and automation with advanced technologies in the context of Industrial revolution 4.0.

CLO3: To understand the role of cyber-physical systems, IoT, and cloud computing in Industrial revolution 4.0.

CLO4: To understand the role of digital twin and cyber security in Industrial revolution 4.0.

CLO5: To analyze and evaluate the impact of Industrial revolution 4.0 on industrial sectors and future trends.

Unit I: Introduction to Industrial revolution 4.0:

Evolution of industrial revolutions: From Industry 1.0 to Industry 4.0, Key concepts and principles of Industry 4.0, Smart factories and cyber-physical systems , Impact of Industry 4.0 on robotics and automation.

Unit II: Advanced Technologies in Industrial revolution 4.0:

Internet of Things (IoT) and its applications in industrial settings, Cloud computing and its role in Industry 4.0, Big data analytics for smart manufacturing, Artificial Intelligence and machine learning in Industry 4.0.

Unit III: Robotics and Automation in Industrial revolution 4.0:

Collaborative robotics and human-robot interaction, Industrial automation systems and control, Sensing and perception technologies in smart factories, Robotic process automation (RPA) and intelligent automation.

Unit IV: Digital Twin and Cyber security in Industrial revolution 4.0:

Digital Twin technology and its applications, Virtual and augmented reality in manufacturing, Data security and privacy in Industry 4.0, Cyber security challenges and solutions in smart factories.

Unit V: Applications and Future Trends in Industrial revolution 4.0:

Smart logistics and supply chain management, Predictive maintenance and condition monitoring, smart energy management and sustainable manufacturing.

TEXTBOOKS:

1. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist.
2. "Robotics and Automation in the Industry 4.0 Era"; by Pedro Neto and Anibal Reñones.

REFERENCE BOOKS:

1. "Digital Twin Technologies and Smart Cities" by Quang Vinh Nguyen et al.
2. "Smart Manufacturing: Innovation and Transformation" by Hui-Ming Wee and Kuan Yew Wong.

Course Outcomes (COs):

CO1: Understand the concepts of technologies used to support industry 4.0 environments.

CO2: Apply the appropriate technologies for industry 4.0

CO3: Apply the knowledge of robotics and automation for achieving increased productivity.

CO4: Understand the concept of digital twin and cyber security

CO5: Analyze and evaluate the impact of Industry 4.0 on various sectors

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL28	Advanced Manufacturing Technology	3	0	0	3

Course Learning Objectives (CLOs):

CLO_1: To analyze and identify applications of advanced manufacturing processes

CLO_2: To understand Additive Manufacturing technology for innovations in product

CLO_3: To understand and analyze the basic mechanisms of advanced machining techniques

CLO_4: To analyze and identify applications of advanced joining processes

CLO_5: To understand various applications and methods of micro and nano fabrication techniques

UNIT I: INTRODUCTION TO ADVANCED MANUFACTURING

Overview of traditional vs. advanced manufacturing, Concepts of Industry 4.0, Cyber-Physical Systems (CPS) in manufacturing, Internet of Things (IoT) and Big Data analytics in manufacturing, Concepts of digital twins in manufacturing

UNIT II: ADDITIVE MANUFACTURING

Introduction to additive manufacturing, additive manufacturing technologies: binder jetting, direct energy deposition, material extrusion, material Jetting, Powder Bed Processes, sheet lamination, Photopolymerization, Design for Additive Manufacturing, Applications of additive manufacturing.

UNIT III: ADVANCED MACHINING PROCESSES

Need for advanced machining processes, Chemical Machining, Electrochemical Machining, Electrical-discharge Machining, Laser-beam Machining, Electron-beam Machining, Water-jet Machining, Abrasive-jet Machining, Hybrid Machining Systems.

UNIT IV: ADVANCED JOINING PROCESSES

Introduction to advanced joining processes, solid state welding, Electron Beam welding, Laser beam welding, Ultrasonic welding, Underwater welding, Cryogenic welding, Thermal spray coatings, Welding of plastics and composites, Explosive joining, diffusion bonding, Adhesive bonding

UNIT V: MICRO-MANUFACTURING

Introduction, Clean Rooms, Semiconductors and Silicon, Crystal Growing and Wafer Preparation, Film Deposition, Lithography, Etching, Diffusion and Ion Implantation, Metallization and Testing, Micromachining of MEMS Devices, Mesoscale Manufacturing, Nanoscale Manufacturing

Course Outcomes (COs):

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

CO_1 Apply the appropriate advance manufacturing techniques

CO_2 Understand and apply various additive manufacturing technology for product development

CO_3 Understand and analyze the basic mechanisms of advanced machining techniques

CO_4 Analyze and identify applicability of advanced joining processes

CO_5 Select appropriate micro and nano fabrication techniques for engineering applications

TEXTBOOKS:

1. Manufacturing Engineering and Technology by Kalpakijian, Addison Wesley, 1995.
2. Foundation of MEMS by Chang Liu, Pearson, 2012.
3. Advanced Machining Processes by V. K. Jain, Allied Publications.

REFERENCE BOOKS:

1. Process and Materials of Manufacturing by R. A. Lindburg, 4th edition, PHI 1990.
2. Introduction to Manufacturing Processes by John A Schey, Mc Graw Hill.
3. Micro Machining of Engineering Materials by J. Mc Geough, CRC Press.
4. Non-Traditional Manufacturing Processes by Gary F Benedict, CRC Press.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL19	Agricultural Robotics	3	0	0	3

Course Learning Objectives (CLOs):

CLO01 To provide basic conceptual understanding of the principles of automation in agriculture

CLO02 To get familiarized on the technologies for precision and site-specific farming.

CLO03 To equip with the skills and abilities for selecting robotic systems for agriculture.

CLO04 To enhance awareness of the cyber physical system for precision farming.

Unit I

Introduction - Concepts and definitions for digital farming, precision agriculture, Sensing and situation, Intelligent decision-making, challenges, and opportunities. Smart cameras, 3D and spectral sensing techniques, crop scouting for precision agriculture.

Unit II

Robotics for unstructured agricultural environments. Manual and robotic farming. Robotic grippers and manipulation optimization in agriculture.

Unit III

Mechatronics for Agriculture. Mechatronic design optimization for agricultural operations, such as weeding, sowing, harvesting, composting, etc., Field robotics and digital farming. Control techniques of heterogeneous agricultural robots and algorithms for interaction. Advanced learning and classification techniques for agriculture.

Unit IV

Collaborative robotic systems in agriculture, adaptive model predictive control in agriculture. Model reference adaptive control for uncertain dynamical systems with disturbances. Drones and satellite guidance-based agriculture for crop management and soil fertility.

Unit V

Case studies: automatic infield sorting and handling of apples, harvesting in tree fruit crops.

Textbooks:

1. Manoj Karkee and Qin Zhang Editors Fundamentals of Agricultural and Field Robotics, Springer (2021)
2. Dan Zhang, Bin Wei, Robotics and Mechatronics for Agriculture, CRC Press (2017)
3. Andrey Ronzhin, Tien Ngo, Quyen Vu, Vinh Nguyen. Ground and Air Robotic Manipulation Systems in Agriculture Springer (2022)

References:

1. K R Krishna, Push Button Agriculture Robotics, Drones, Satellite-Guided Soil and Crop Management, AAP (2016)
2. K.R. Krishna, Aerial Robotics in Agriculture Parafoils, Blimps, Aerostats, and Kites, AAP (2021)

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Analyze and select an automation strategy for agricultural applications.

CO_{02} Understand different sensors and actuators used for agriculture.

CO_{03} Apply motion planning techniques for robots in agriculture.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL38	Advanced Materials for Robotics	3	0	0	3

Course Learning Objectives (CLOs):

CLO$_{01}$ To impart the basic concepts of cell biology, evolutionary systems, neuroscience and immune systems in relation to robotics.

CLO$_{02}$ To familiarize the connection between biology and robotics and how biology inspires robotics.

CLO$_{03}$ To familiarize the different types of robots developed based on biology.

Unit I

Advanced metallic materials- Fundamental principles of advanced materials and application of advanced materials to robotics using a multidisciplinary science-based approach. Liquid-solid transformation-Nucleation and kinetics of growth, interface morphologies, nonequilibrium freezing, segregation. Nucleation in the solid state- transformations, diffusion in solid state, diffusion equations for steady state and transient conditions.

Unit II

Structural Materials for Robots – Aluminum, copper, magnesium, steel, nickel and titanium alloys. Recent advances in materials development- Hi-Entropy alloys, functionally gradient materials, shape memory alloys, metallic composite for soft robotics, computational materials.

Unit III

Composites in robotics- Types of matrices and reinforcements, principles, properties and applications, stretchable elastomeric sensor and ionic polymer for robotics, Kevlar,

biodegradable smart materials, macroscopic composites, three-dimensional, periodic cellular architecture. Special processing techniques of material for robotics.

Unit IV

Introduction to thin film sand sensor material, energy material and refractory materials and characterization. Materials characterization techniques for advanced and robotic material – Recap of mechanical, metallurgical, chemical and thermal methods.

Unit V

Instrumentational methods – Scanning electron microscopy, transmission electron microscopy and energy dispersive analyses, X-ray diffraction, atomic force microscopy, Field array NDT techniques for futuristic materials, surface patterning techniques.

Textbooks:

1. Bhushan Bharat, "Springer Handbook of Nanotechnology", Springer, 2017.
2. Sohel Rana and Raul Fangueiro, "Advanced Composite Materials for Aerospace Engineering: Processing,
3. Properties and Applications", Woodhead Publishing, 2016.
4. Rowe Jason, "Advanced Materials in Automotive Engineering", Woodhead Publishing, 2016.
5. Cantor Brian, Hazel Assender and Patrick Grant, "Aerospace Materials", CRC Press, 2015.
6. Park Joon and Roderic S. Lakes, "Biomaterials: an Introduction", Springer Science & Business Media, 2007.
7. Cao Guozhong, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", Imperial College Press, 2004.

References:

1. Michio Inagaki Feiyu Kang Masahiro Toyoda Hidetaka Konno, "Advanced Materials Science and Engineering of Carbon", 1st Edition, Butterworth-Heinemann, 2013, ISBN: 9780124077898.

2. Gaskell, David R., “Introduction to Metallurgical Thermodynamics”, McGraw Hill, 1973.
3. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
4. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, 2005.
5. Michael Shur, "Physics of Semiconductor Devices", Prentice Hall of India, 1995.
6. Charles P Poole Jr., and Frank J. Ownes, “Introduction to Nanotechnology”, John Wiley Sons, Inc., 2003.
7. M. H. Loretto, “Electron Beam Analysis of Materials”, Chapman and Hall, 1984.
8. Seymour and Carraher, “Polymer chemistry”, Marcel Dekker, 2003.
9. Sam Zhang, Lin Li and Ashok Kumar, “Materials Characterization Techniques”, CRC Press, (2008).

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Explore the knowledge about thermodynamics of nucleation and strengthening mechanisms.

CO_{02} Analyze metallic, functional and polymer materials and its processing.

CO_{03} Explain knowledge in high performance materials and techniques for robotics.

CO_{04} Analyze structure properties, and performance using advanced material characterization technique.

Course Code	Course Name	L	T	P	Total Credits
RA3EL24	Smart Sensors	3	0	0	3

Course Learning Objectives

CLO$_{01}$ To familiarize the available physical phenomena behind the operation of different types of sensors and microsystems.

CLO$_{02}$ To design sensors with appropriate electronic interfaces as a complete system.

CLO$_{03}$ Discuss how sensors enable data collection and automation in IoT applications

CLO$_{04}$ Evaluate the trade-offs in choosing specific sensor technologies for different applications.

Unit I

Definition and Classification of Sensors- Self-calibration, Self-testing & self-communicating, Selection criteria for sensing technologies, Sensor Components, Communication interfaces, Architecture of Smart Sensors, Integration with microcontrollers and microprocessors, Importance of sensors in modern technology, Advantages and disadvantages of smart sensors, Sensing Technologies, Overview of different sensing technologies (e.g., chemical, optical, thermal),

Unit II

Acoustic Sensors, Mechanical Sensors, Piezoelectric sensors and materials, Saw sensors, Integrated Hall sensors, Magnetic sensors, Magneto-transistors, other magnetics transistors and future trends, Radiation Sensors, Thermal Sensors and Chemical Sensors, Radiation basics - HgCdTe infrared sensors, Visible-light color sensors - high-energy photodiodes,

Interaction of gaseous species at semiconductor Surfaces - Catalysis - the acceleration of chemical reactions - Thin-film sensors - FET devices for gas and ion sensing.

Unit III

Micro-and Nanotechnologies or Sensors - Fundamentals of MEMS fabrication, introduction and description of basic processes, MEMS fabrication technologies, bulk micromachining, Surface micromachining, High- aspect-ratio (LIGA and LIGA-Like) technology microfluidics microsystem components, Microfluidics microsystem components, Nanotechnology - product prospects - application trends Procedures and techniques, the making of ultrathin films Creation of lateral nanostructures - clusters and Nano crystalline materials and principles of self-organization and Future trends.

Unit IV

IoT Basics, Introduction to IoT and its components, Role of sensors in IoT, Integration of Smart Sensors with IoT, Communication protocols (e.g., MQTT, CoAP), Cloud computing for data storage and analysis, IoT Basics, Introduction to IoT and its components, Role of sensors in IoT, Integration of Smart Sensors with IoT, Communication protocols (e.g., MQTT, CoAP)

Cloud computing for data storage and analysis

Unit V

Fabrication of Sensor and Smart Sensor, Integration of Micromachining and Microelectronics, Wafer bonding, Standard of Smart Sensor Network, Communication for smart sensors, Role of smart sensors in environmental monitoring, smart grids, battlefield reconnaissance, exploration, Industrial applications of smart sensors, emerging technologies in sensor development, challenges and opportunities in smart sensor implementation

Textbooks:

1. Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer; 4th ed. 2010.
2. S. M. Sze, “Semiconductor Sensors”, Wiley-Interscience, 1994.

References:

1. Gerard Meijer, “Smart sensor systems”, Wiley, 2008.
2. W Gopel, J. Hesse, J. N. Zemel, “Sensors A Comprehensive Survey”, Vol. 9, Wiley-VCH, 1995.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Explain the available physical phenomena behind the operation of different types of sensors and microsystems.

CO_{02} Design the sensors with appropriate electronic interface as a complete system.

CO_{03} Analyze and apply sensors in robotics and automation.

CO_{04} Design and fabricate the process of MEMS fabrication.

Course Code	Course Name	Hours per Week			Credits
		L	T	P	
RA3EL17	Advanced Drones Technology	3	0	0	3

Course Learning Objectives (CLOs):

CLO$_{01}$ To familiarize with the basic concepts of drones, propellers, and controls of drones.

CLO$_{02}$ To impart the state estimations and path planning of drones.

Unit I

Fixed Wing and Multirotor Micro Drones: Introduction – Drones – Kinematic and dynamics modelling formulation of drones - Transformation and representations.

Unit II

Dynamics of a fixed-wing drones, Propeller theory – Thrust and drag moment – Dynamics of a multi rotor micro drones (MMD) – Mathematical modelling of MMD

Unit III

State Estimation: Physics and working of Navigational sensors – Inertial Sensors – Magnetometer – Pressure sensors, GPS – Camera based navigation – Kalman filter – Position and velocity analysis, Inertial navigation systems – Attitude estimation

Unit IV

Flight Controls and Motion Planning: PIC control – Lateral control of MMD, LQR – Design of servo LQR control, Linear model predictive control – Design and implementation.

Unit V

Holonomic vehicle boundary value solver, Dubins airplane model boundary value solver – collision free navigation, Structural inspection path planning.

Textbooks:

1. R. Beard, and T. W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2012
2. R. C. Nelson, "Flight Stability and Automatic Control", McGraw Hill, New York, 1998.

References:

1. L.R. Newcome, Unmanned Aviation, a Brief History of Unmanned Aerial Vehicles, American Institute of Aeronautics and Astronautics, Reston, 2004.
2. Kuo, B. C., "Automatic Control Systems", Prentice Hall, 1991

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Solve the kinematics and dynamics of fixed wing drones.

CO_{02} Solve the kinematics and dynamics of fixed wing drones multi rotor micro drones.

CO_{03} Design the flight controls of drones.

CO_{04} Design and develop path planning algorithms for drones.

Course Code	Course Name	Hours per Week			Total Credits
		L	T	P	
RA3EL38	Industrial Data Analytics and Decision Making	3	0	0	3

Course Learning Objectives (CLOs):

Students will be able to

CLO 01 Understand and apply key statistical concepts in industrial data analytics.

CLO 02 Master data collection methods and data cleaning techniques for analytics readiness.

CLO 03 Learn data presentation techniques and descriptive measures for comprehensive data analysis.

CLO 04 Master advanced statistical methods for rigorous data analysis.

CLO 05 Understand decision theory and its applications in statistical analysis.

Unit 1: Introduction to Industrial Data Analytics

Overview of Industrial Data Analytics, Statistical Terms and Concepts- Data, Variable, A Random Variable, Population, Sample, A Random Sample etc., Descriptive Statistics- Basic Elements, Characteristics, Function, Limitation of Statistics, Industrial Data Analytics and its significance in enhancing Decision-Making processes in Manufacturing and Industrial Sectors.

Unit 2: Data Collection and Data Preparation

Data Collection: Data type, Data Gathering- planning of study, Data Collection Methods- direct personal observation, telephone survey, indirect personal interview, IoT Sensors and Devices, Web Scraping Techniques, Transactional Data Collection, Text Mining and Analysis, Statistical and Machine Learning Approaches, Mailed Questionnaire Method, Questionnaire sent through Enumerators, Drafting or Framing of Questionnaire Data Cleaning and Transformation: Data Quality Assessment, Techniques for Data Cleaning (e.g., handling missing data, outlier detection), Data Integration and Transformation, Normalization and Standardization, Structuring Data for Analysis

Unit 3: Data Presentation and Descriptive Measure

Data Presentation: constructing a frequency distribution, graphic presentation- bar diagrams, pie diagram, pictograms, histogram, frequency polygon, cumulative frequency curve (Ogive). Descriptive Measure: Central Tendency-Mean, Mode and Median, Measure of Dispersion (Ungrouped Data)- Range, Inter-Quartile Range, The Variance and The Standard Deviation, Coefficient of Variation, Measure of Skewness, Sampling Distribution.

Unit 4: Advanced Statistical Methods in Data Analysis

Advanced hypothesis testing methods such as z-tests and t-tests, one-way ANOVA with an emphasis on assumptions and diagnostics, simple and multiple linear regression for modelling and diagnostics, correlation analysis, an overview of predictive modeling techniques including model selection and performance metrics, introduction to Structural Equation Modeling (SEM) for confirmatory factor analysis and path analysis, and practical applications using statistical software with real-world case studies across different domains.

Unit 5: Statistical Decision Making

Introduction to decision theory and its role in statistical analysis, Multiple Objective Decision Making (MODM), Multiple Criteria Decision Making (MCDM), decision under certainty, decision making under risk, decision under uncertainty, Bayesian Decision Making, Decision support systems (DSS), Advanced Decision Making Techniques- Interpretive Structural Modeling (ISM), Analytic Hierarchy Process (AHP), Decision Models: Decision Trees, Monte Carlo Simulation, Real-Time Decision Making and Dashboards.

Textbooks:

1. Chandan, J. S., Singh, J., & Khanna, K. K. (2014). Business statistics. Vikas Publishing House.

2. Israel, D. (2009). Data analysis in business research: A step-by-step nonparametric approach. Sage Publications.

3. S. Christian Albright, Wayne L. Winston, and Christopher J. Zappe, "Business Analytics: Data Analysis & Decision Making", Cengage Learning.

4. Peck, Roxy, Velleman, Paul D., and Bock, Ronald D., "Statistics for Engineers and Scientists", Cengage Learning.

Reference Books:

1. Robert Nisbet, John Elder, Gary Miner, "Handbook of Statistical Analysis and Data Mining Applications", Academic Press.

2. Max Kuhn, Kjell Johnson, "Applied Predictive Modeling", Springer.

3. Andrew Gelman and Jennifer Hill, "Data Analysis Using Regression and Multilevel/Hierarchical Models", Cambridge University Press.

4. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, "Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer.

Course Outcomes (COs):

After completion of this course student will be able to:

CO 01 Utilize descriptive statistics for effective analysis in manufacturing decision-making processes.

CO 02 Apply effective data collection and cleaning methods to prepare structured data for analysis.

CO 03 Effectively present data graphically and calculate central tendency and dispersion measures for analytical purposes.

CO 04 Apply advanced statistical techniques using software for real-world case studies.

CO 05 Apply advanced statistical decision-making techniques effectively.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00047	Open Elective-III Advanced Machining Process	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} To develop the ability to understand the need of modern machining processes and their classification and the mechanical type advanced machining processes

CLO_{02} To be able to understand the various Chemical and Electrochemical Type Advanced Machining Processes

CLO_{03} To understand Thermal Type Advanced Machining Processes

CLO_{04} To understand various Hybrid Advanced Machining Processes

CLO_{05} To understand different types of Hybrids Finishing Processes.

Unit I

Mechanical Type Processes : Limitations of conventional machining process, classification of advanced machining processes, **Classification of mechanical type processes** : Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - abrasive jet machining (AJM), ultrasonic machining (USM), water jet machining (WJM), recent developments in all the processes.

Unit II

Chemical and Electrochemical Type Processes : Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - chemical machining (CHM), maskants and its type, methods of applying maskants, Electrochemical machining[ECM], electrolyte flow design in ECM.

Unit III

Thermal Processes : Principle and mechanics of metal removal, calculation of MRR , process parameters and their effect on MRR , machine setup , advantages limitations and applications of - electric discharge machining(EDM), different circuits of pulsating dc supply, wire-cut EDM, transferred and non-transferred arc type plasma arc machining (PAM), Electron beam machining(EBM) and Laser Beam machining (LBM).

Unit IV

Hybrid Processes: Principle and mechanics of metal removal, advantages, disadvantages and limitations of – abrasive electro-discharge machining (AEDM), ultra sonic assisted EDM (EDMUS), laser assisted ECM (ECML) ,ultra sonic assisted ECM (USECM)

Unit V

Hybrid Finishing Processes: Working principle, applications, advantages and limitations of - electrochemical grinding (ECG), electro-discharge grinding (EDG), electrochemical de-burring (ECD), electrochemical honing (ECH), magnetic abrasive finishing (MAF),

Text Books:

1. P.C. Pandey and H.S.Shan, "Modern Machining processes", McGraw Hill Education
2. M.K.Singh, "Unconventional Manufacturing Processes" New Age International
3. Hassan Abdel-Gawad El-Hofy, "Advanced Machining processes", McGraw Hill

Reference Books:

1. G.F. Benedict, Marcel Dekker,Nontraditional Manufacturing Processes", Inc. New York.
2. Vijay.K. Jain, "Advanced Machining Processes" Allied Publishers.
3. Amitabha Ghosh and Asok Kumar Mallick, "Manufacturing Science", East West Press.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Understand the need of modern machining processes and their classification and various types of advance machining processes.

CO_{02} Understand the various mechanical type, Chemical and Electrochemical type, Thermal Type Advance Machining Processes

CO_{03} Understand the various Hybrid Advance Machining Processes and Hybrid Finishing Processes

CO_{04} Analyze the role of the various Advance Machining Processes in Industries

CO_{05} Apply the knowledge of Advance Machining Process to do the machining of modern strong alloys

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00084	Open Elective-III Start-up Creation through Experimental Learning	3	0	0	3

Course Learning Objectives (CLOs):

CLO01 To understand concepts of entrepreneurial thinking, opportunity evaluation and market type.

CLO02 To understand the concepts of value proposition canvas, lean canvas and refining the business model.

CLO03 To understand the concepts of minimum viable product and prototype.

CLO04 To understand the concepts of market validation and sustainability.

CLO05 To understand the concepts of financial feasibility and funding options in early stage startups.

Unit I: Problem Identification and Opportunity Discovery

Conduct Opportunity Discovery, Problem Validation, Sharpen their Problem Pitch

Customer and Markets**:** Identify the Market Type, Explore Market Segment, Determine Market Positioning, Create the Customer Persona

Unit II: Sustainable Differentiation Strategy

Craft your core value proposition; create a Sustainable Differentiation Strategy, Analyze Competition.

Competitive Advantage: Identify competitors, Identify critical product features, Conduct feature ranking and estimate a product road-map

Unit III: Business Model

Build and test a business model, Pivot or Persevere, Identify the riskiest assumptions in the business model.

Competitive Advantage: Build your prototype, Test with early adopters, Conduct Customer Interviews; Refine the Prototype, Build Minimum Viable Product.

Unit IV: Business model sustainability

Ascertain Costs, Arrive at appropriate pricing strategy, Financial Projections, Key Financial Metrics.

Go To market Strategy: Identify the appropriate channels, Build Strategic partnerships, Create Digital Marketing Plan, Devise a Market penetration strategy.

Unit V: Managing growth and Targeting Scale

Devise a Growth Plan, Structure the Scaling Strategy, Customer acquisition; enhancing productivity, Process improvements, Operational excellence, manage money

Funding Strategy: Create Sources and uses of Funds Statement, Map the Start-up Lifecycle to Funding Options; Valuation, Create the Pitch Deck

Text Books:

1. Elias G. Carayannis, Elpida T. Samara, Yannis L. Bakouros, (2015). Innovation and Entrepreneurship Theory, Policy and Practice, Springer International Publishing Switzerland.
2. Hisrich, Robert. Michael Peters and Dean Shepherd, Mathew. (2014). Entrepreneurship. New Delhi: Tata McGraw-Hill Education.
3. Poornima M., (2014), Entrepreneurship Development and Small Enterprise, Pearson Education.

Reference Books:

4. Martha Corrales-Estrada,(2019), "Innovation and Entrepreneurship: A New Mindset for Emerging Markets", Emerald Publishing Limited.
5. Eric Ries, (2017). "The startup way: how modern companies use entrepreneurial management to transform culture and drive long-term growth", New York: Currency.
6. Howard H Frederick; Donald F Kuratko; Allan O'Connor, (2016). "Entrepreneurship: theory, process, practice", South Melbourne, Victoria: Cengage Learning.

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} To understand concepts of entrepreneurial thinking, opportunity evaluation and market

type.

CO_{02} To understand the concepts of value proposition canvas, lean canvas and business model.

CO_{03} To understand the concepts of minimum viable product and prototype.

CO_{04} To understand the concepts of market validation and sustainability.

CO_{05} To understand the concepts of financial feasibility and funding options in early stage startups.

Course Code	Course Name	Hours per Week			Total
		L	T	P	Credits
OE00048	Open Elective-III Supply Chain Management	3	0	0	3

Course Learning Objectives (CLOs):

CLO_{01} Define and formulate linear programming problems and appreciate their limitations.

CLO_{02} Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action.

CLO_{03} Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.

CLO_{04} Develop mathematical skills to analyse and solve integer programming and network models arising from a wide range of applications.

CLO_{05} Develop mathematical skills to analyse and solve inventory models arising from a wide range of applications.

Unit I

Introduction &Building a Strategic Framework to Analyze Supply Chains: An Introduction, Strategic view of supply chains, Evolution of Supply Chain Management (SCM), Importance of the supply chain, Decision phases in a supply chain, Process views of supply chain, Enablers of supply chain performance, Supply chain strategy and performance measures–competitive and supply chain strategies – Achieving strategic fit, managing material flow in supply chain

Unit II

Designing the Supply Chain Network: Designing distribution networks and applications to e-business, network design in the supply chain, network designing an uncertain environment, supply chain planning, supply chain coordination, decision modeling for supply chain, green supply chain

Unit III

Supply Chain Distribution and Integration and Risk Pooling : Supply chain integration, Warehouse Management Systems, Storage Systems, Material Handling Requirements, Distribution Strategies – Traditional Retail, Direct Shipping, Cross-docking, Cross-dock Operations,

Distribution Strategies: Pool Distribution, Trans shipment, Milk-Run Systems, Classic Techniques of Risk Management, Pooling based on Location, Product, lead Time and capacity.

Unit IV

Supplier Relationship Management: Integrating Suppliers into the e-Value Chain : Defining Purchasing and Supplier Relationship Management, Components of SRM, The Internet-Driven SRM Environment, e-SRM Structural Overview, e-SRM Services Functions, e-SRM Processing, e-SRM Technology Services, Anatomy of The e-SRM Marketplace Exchange Environment, Implementing e-SRM

Unit V

Transportation and Packaging : Transportation – Drivers, Modes, Measures - Strategies for Transportation, 3PL and 4PL, Vehicle Routing and Scheduling. Packaging- Design considerations, Material and Cost. Packaging as Unitisation. Consumer and Industrial Packaging.

Text Books:

1. Ronald H. Ballou and Samir K. Srivastava, Business Logistics and Supply Chain Management, Pearson education
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education
3. Mohanty R.P and Deshmukh S.G, Supply chain theories and practices, Biztantra publications.

Reference Books:

1. Bowersox Donald J, Logistics Management – The Integrated Supply Chain Process,Tata McGraw Hill
2. Vinod V. Sople, Logistics Management-The Supply Chain Imperative, Pearson.
3. Coyle et al., The Management of Business Logistics, Thomson Learning

Course Outcomes (COs):

After completion of this course the students shall be able to:

CO_{01} Become familiar with current supply chain management trends Understand and apply the current supply chain theories, practices and concepts utilizing case problems and problem-based learning situations

CO_{02} Formulate and implement Warehouse Best Practices and Strategies

CO_{03} Plan Warehouse and Logistics operations for optimum utilization of resources

CO04 Identify and Analyse Business Models, Business Strategies and, corresponding Competitive Advantage.

CO05 Develop and utilize critical management skills such as negotiating, working effectively within a diverse business environment, ethical decision making and use of information technology

Course Code	Course Name	Hours Per Week			Total Credits
		L	T	P	
RA3PC12	Project-I	0	0	8	4

1. Project-I can be an individual or a group activity depending on the depth and scope of the topic.
2. The project work can be any of the form given below:

a) Making physical working models, prototypes, and scaled models of a concept machine.
b) Making virtual / CAD models of a sufficiently complex machines / concepts.
c) Making study, modeling, analysis, programming and simulation of a system / machine /operation / process.
d) Making study / teaching modules of a sufficiently complex topic for pedagogy purposes.

3. Group formation, discussion with faculty advisor, formation of the Semester Mini Project statement, resource requirement, if any should be carried out in the earlier part of the semester.
4. The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.
5. A complete Assembly and Details drawings of the project should be submitted along with a Detailed project report, where applicable.
6. A Detailed Background / field / literature survey, related to the topic must be made and presented in the report.

Course Code	Course Name	Hours Per Week			Total Credits
		L	T	P	
RA3PC03	Industrial Training	0	2	0	2

Industrial Training is a structured program that integrates academic learning with practical industrial experience. It is designed to bridge the gap between theoretical knowledge gained in the classroom and real-world applications in the industry. This program is essential for students in engineering, technology, and related fields as it provides hands-on experience and exposure to actual working environments.

Objectives of Industrial Training:

1. **Skill Development:** Enhance practical skills and technical knowledge that are crucial for industry-specific tasks.
2. **Workplace Experience:** Provide firsthand experience of the professional work environment, including workplace culture, practices, and expectations.
3. **Application of Knowledge:** Enable students to apply academic concepts and theories to real-world industrial problems and projects.
4. **Professional Networking:** Offer opportunities to build connections with industry professionals, which can be valuable for future career prospects.
5. **Career Insight:** Help students gain insights into potential career paths and make informed decisions about their professional future.

Key Components of Industrial Training:

1. **Orientation:** Introduction to the company, its operations, safety protocols, and expectations during the training period.
2. **Hands-on Projects:** Participation in live projects and tasks relevant to the student's field of study, under the guidance of experienced professionals.
3. **Mentorship:** Regular interaction with mentors and supervisors who provide guidance, feedback, and support throughout the training.
4. **Evaluation:** Continuous assessment of the student's performance through reports, presentations, and evaluations by industry mentors.
5. **Reflection:** Opportunities for students to reflect on their experiences, challenges faced, and lessons learned during the training.

Course Code	Course Name	Hours Per Week			Total Credits
		L	T	P	
EN3NG06	Open learning Courses	1	0	0	1

Open Learning Courses are educational programs designed to be accessible to a broad audience, often offered online and available to anyone with an internet connection. These courses aim to make education more inclusive and flexible, allowing learners to study at their own pace and according to their own schedules.

Objectives of Open Learning Courses:

1. **Accessibility:** Provide educational opportunities to learners regardless of their geographical location, financial situation, or prior educational background.
2. **Flexibility:** Allow learners to study at their own pace and on their own schedule, accommodating diverse learning styles and life commitments.
3. **Lifelong Learning:** Encourage continuous personal and professional development by providing access to a wide range of subjects and skill sets.
4. **Inclusivity:** Promote equal access to high-quality education for all, reducing barriers related to cost, location, and time.

SEMESTER VIII

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	RA3PC13	Project-2	0	0	22	11
		Total	**0**	**0**	**22**	**11**
		Total Contact Hours	**22**			

1. Project-II can be an individual or a group activity depending on the depth and scope of the topic.

1. The project work can be any of the form given below:

a) Making physical working models, prototypes, and scaled models of a concept machine.
b) Making virtual / CAD models of sufficiently complex machines / concepts.
c) Making study, modeling, analysis, programming and simulation of a system / machine /operation / process.
d) Making study / teaching modules of a sufficiently complex topic for pedagogy purposes.

3. Group formation, discussion with faculty advisor, formation of the Semester Mini Project statement, resource requirements, if any should be carried out in the earlier part of the semester.

4. The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.

5. A complete Assembly and Details drawings of the project should be submitted along with a Detailed project report, where applicable.

6. A Detailed Background / field / literature survey, related to the topic must be made and presented in the report.