DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

PERAMBALUR - 621212

REGULATIONS–2023

CHOICE BASED CREDIT SYSTEM

B.E. ROBOTICS AND AUTOMATION

CURRICULUM & SYLLABI

DEPARTMENT OF ROBOTICS AND AUTOMATION

(Applicable to students admitted from the Academic year 2023 – 2024 and subsequently under Choice Based Credit System)

VISION MISSION OF THE INSTITUTUION

Vision:

An active and committed centre of advanced learning focused on research and training in the fields of Engineering, Technology and Management to serve the nation better.

Mission:

- To develop eminent scholar with a lifelong follow up of global standards by offering UG,PG and Doctoral Programmes.
- To pursue Professional and Career growth by collaborating mutually beneficial partnership with industries and higher institutes of research.
- To promote sustained research and training with emphasis on human values and leadership qualities.
- To contribute solutions for the need based issues of our society by proper ways and means as dutiful citizen.

DEPARTMNET OF ROBOTICS AND AUTOMATION

The department of Robotics and Automation was established on the year of 2017, offers B.E Robotics and Automation programme and it was affiliated to Anna University, Chennai. The curriculum and syllabus for the programme is designed by envisaging the future needs in the industry including the hands-on experience of Robotics and Automation Theory & Practice.

Vision:

To develop robotics and automation engineers with systems and interdisciplinary approach keeping pace with emerging technologies with a concern for society.

Mission:

- To develop highly technical knowledge, solid foundational skills, practical knowledge, and creative understanding for successful robotics and automation professionals.
- To offer a high-quality educational experience that complies with industry standards.
- To foster research and development for the betterment of the international community.
- To encourage the entrepreneurial qualities essential to set up, develop, and lead multinational engineering firms.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	The program aims to develop a proficient engineer in Robotics and Automation field to serve the various technological needs of Industry and Society.
PEO 2	To develop the engineers to practice the multidisciplinary engineering knowledge in particularly in mechanical, electrical, electronic, control, manufacturing and software for Robotics and Automation systems development.
PEO 3	The program shall create engineers continuously to uplift the knowledge, skill, attitude, self- learning, teamwork, value of ethics and able to protect environmental eco-systems.

PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles ofmathematics, natural sciences, and engineering sciences.
PO3	**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 the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation ofdata, and synthesis of the information to provide valid conclusions.
PO5	**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.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequentresponsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, andneed for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: 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 technologicalchange.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1	**Multi-disciplinary Engineering in Robotics:** Analyse the real world needs and design the robot and Automation solutions using the competency in multi domain engineeringelements and integrated software tools.	
PSO 2	**Enhancement and upgradation:** Analyse conventional functions and process ofvarious engineering elements and propose robots and automation solution for enhanced performance of conventional systems.	
PSO 3	**Robotic system integration and automated Solution and connectivity:** Recommend the sensing, interfacing, controlling, actuating, communicating technologies andanalysing the data through various subsystems and build the robots.	

PEO's – PO's & PSO's MAPPING:

PEO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
I.	3	2	3	2	3	1	1	1	3	1	1	1	2	3	2
II.	3	2	3	2	2	2	2	1	2	1	2	2	3	2	3
III.	3	3	2	2	1	2	3	3	3	2	3	1	2	2	3

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE
(AUTONOMOUS), PERAMBALUR – 621 212
B.E. ROBOTICS AND AUTOMATION

REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	IP3151	Induction Programme	-					0
THEORY								
2	U23HST11	Communicative English	HSMC	3	0	0	3	3
3	U23MAT12	Matrices and Calculus	BSC	3	1	0	4	4
4	U23PHT13	Physics for Engineers and Technologists	BSC	3	0	0	3	3
5	U23CYT14	Chemistry for Engineering and Technology	BSC	3	0	0	3	3
6	U23GET16	Engineering Graphics	ESC	2	0	4	6	4
7	U23GE3152	தமிழர்மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICAL								
8	U23BSP11	Physics and Chemistry Laboratory	BSC	0	0	3	3	2
9	U23HSP12	English Laboratory	HSMC	0	0	2	2	1
10	U23GEP14	Engineering Practices Laboratory	ESC	0	0	4	4	2

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23HST21	Professional Communication	HSMC	3	0	0	3	3
2	U23MAT22	Statistics and Numerical Methods	BSC	3	1	0	4	4
3	U23GET15	Problem Solving and Python Programming	ESC	3	1	0	4	4
4	U23PHT23	Applied Material Science	BSC	3	0	3	6	3
5	U23EET24	Basic Electrical, Electronics Engineering and Measurements	ESC	3	0	0	3	3
6		NCC Credit Course Level 1	-	2	0	0	2	2
7	U23GE3252	தமிழரும்தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
PRACTICAL								
8	U23EEP23	Basic Electrical, Electronics Engineering and Measurements Laboratory	ESC	0	0	4	4	2
9	U23HSP22	Communication Laboratory	EEC	0	0	4	4	2
10	U23HSP13	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MAT31	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2	U23RAT31	Fluid Mechanics and Machinery	ESC	3	0	0	3	3
3	U23MET21	Engineering Mechanics	ESC	3	0	0	3	3
4	U23RAT32	Digital Electronics and Microprocessor	PCC	3	0	0	3	3
5	U23RAT33	Electrical Drives and Actuators	PCC	3	0	0	3	3
6	U23RAT34	Manufacturing Technology	PCC	3	0	0	3	3
7		Interfacing Sensors with Robotic Controller		3	0	0	3	2
PRACTICAL								
8	U23RAP31	Electrical Drives and Actuators Laboratory	PCC	0	0	4	4	2
9	U23RAP32	Manufacturing Technology Laboratory	PCC	0	0	4	4	2

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAT41	Design of Robot Elements	PCC	3	0	0	3	3
2	U23RAT42	Sensors and Instrumentation	PCC	3	0	0	3	3
3	U23RAT43	Control Systems Engineering	PCC	3	0	0	3	3
4	U23RAT44	Robot Kinematics	PCC	3	0	0	3	3
5	U23RAT45	Robot Path Planning andProgramming	PCC	3	0	0	3	3
6	U23GET41	EnvironmentalSciencesand Sustainability	ESC	2	0	0	2	2
7		NCC CreditCourseLevel 2#			0	0		
PRACTICAL								
8	U23RAP41	Sensors and Instrumentation Laboratory	PCC	0	0	4	4	2
9	U23RAP42	Robot Modelling and Simulation Laboratory	PCC	0	0	4	4	2
10	U23RAP43	Control System Engineering Laboratory	PCC	0	0	4	4	2

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAT51	Embedded Systems and Programming	PCC	3	0	0	3	3
2	U23RAT52	Fluid Power Systems and IndustrialAutomation	PCC	3	0	0	3	3
3		Professional Elective I	PEC	3	0	0	3	3
4		ProfessionalElectiveII	PEC	3	0	0	3	3
5		Professional Elective III	PEC	3	0	0	3	3
PRACTICAL								
6	U23RAP51	Fluid Power Systems and Automation Laboratory	PCC	0	0	4	4	2
7	U23RAP52	Embedded Systems Laboratory	PCC	0	0	0	4	2
8	U23GE3361	Professional Development	EEC	0	0	2	2	1

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAT61	Robot Dynamics and Control	PCC	3	0	0	3	3
2	U23RAT62	Machine Learning for Intelligent System	PCC	3	0	0	3	3
3		ProfessionalElectiveIV	PEC	3	0	0	3	3
4		ProfessionalElective V	PEC	3	0	0	3	3
5		OpenElective–I	OE	3	0	0	3	3
6		NCC CreditCourseLevel 3#						
PRACTICAL								
7	U23RAP61	Robot Kinematics and DynamicsLaboratory	PCC	0	0	4	4	2
8	U23RAP62	Inovation laboratory	EEC	0	0	4	2	2
9	U23HSP61	Professional Communication Laboratory	EEC	0	0	2	2	1

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAT71	Robotic Vision System	PCC	3	0	0	3	3
2	U23RAT72	Mobile Robotics	PCC	3	0	0	3	3
3		OpenElective–II	OE	3	0	0	3	3
4	U23GET61	Human Values and Ethics	HSMC	2	0	0	2	2
5		Professional Elective VI	PEC	3	0	0	3	3
PRACTICAL								
6	U23RAP71	Robotics and Intelligence Laboratory	PCC	0	0	4	4	2
7	U23RAP72	ProjectWork -I	EEC	0	0	4	4	2

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		ProfessionalElectiveVII	PEC	3	0	0	3	3
2		ProfessionalElectiveVIII	PEC	3	0	0	3	3
PRACTICAL								
3	U23RAP81	ProjectWork -II	EEC	0	0	20	20	10

PROFESSIONAL ELECTIVES (VERTICALS)			
APPLIED ROBOTICS	**MANUFACTURING SYSTEMS**	**SMART MOBILITY SYSTEMS**	**AUTOMATION**
Robots and Systems in Smart Manufacturing	Computer Integrated Manufacturing	Automobile Engineering	Power Electronics
Drone Technologies	Advanced Manufacturing Systems	Automotive Mechatronics	Object OrientedProgramming in C++
Micro robotics	Additive Manufacturing	Smart mobility and Intelligent Vehicles	Computer Architecture andOrganisation
Agricultural Robotics and Automation	Computer Aided Inspection and Testing	Electric and Hybrid Vehicles	Virtual Instrumentation
Collaborative Robotics	Reliability and Maintenance Engineering	Aircraft Mechatronics	Industrial NetworkProtocols
Humanoid Robotics	CNC Machine Tools and Programing	Navigation and Communication System	Motion Control System
Medical Robotics	Advanced Machining Process	Avionics	Total integrated Automation
Robot Operating Systems	Industrial Safety	Advanced Driver Assistance Systems	Digital Twin and Industry5.0

VERTICALS – I (APPLIED ROBOTICS)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAV11	Robots and Systems in Smart Manufacturing	PEC	3	0	0	3	3
2	U23RAV12	Drone Technologies	PEC	3	0	0	3	3
3	U23RAV13	Micro robotics	PEC	3	0	0	3	3
4	U23RAV14	Agricultural Robotics and Automation	PEC	3	0	0	3	3
5	U23RAV15	Collaborative Robotics	PEC	3	0	0	3	3
6	U23RAV16	Humanoid Robotics	PEC	3	0	0	3	3
7	U23RAV17	MedicalRobotics	PEC	3	0	0	3	3
8	U23RAV18	Robot Operating Systems	PEC	3	0	0	3	3

VERTICALS – II (MANUFACTURING SYSTEMS)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAV21	Computer Integrated Manufacturing	PEC	3	0	0	3	3
2	U23RAV22	Advanced Manufacturing Systems	PEC	3	0	0	3	3
3	U23RAV23	Additive Manufacturing	PEC	3	0	0	3	3
4	U23RAV24	Computer Aided Inspection and Testing	PEC	3	0	0	3	3
5	U23RAV25	Reliability and Maintenance Engineering	PEC	3	0	0	3	3
6	U23RAV26	CNC Machine Tools and Programing	PEC	3	0	0	3	3
7	U23RAV27	Advanced Machining Process	PEC	3	0	0	3	3
8	U23RAV28	Industrial Safety	PEC	3	0	0	3	3

VERTICALS – III (SMART MOBILITY SYSTEMS)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAV31	Automobile Engineering	PEC	3	0	0	3	3
2	U23RAV32	Automotive Mechatronics	PEC	3	0	0	3	3
3	U23RAV33	Smart mobility and Intelligent Vehicles	PEC	3	0	0	3	3
4	U23RAV34	Electric and Hybrid Vehicles	PEC	3	0	0	3	3
5	U23RAV35	Aircraft Mechatronics	PEC	3	0	0	3	3
6	U23RAV36	Navigation and Communication System	PEC	3	0	0	3	3
7	U23RAV37	Avionics	PEC	3	0	0	3	3
8	U23RAV38	Advanced Driver Assistance Systems	PEC	3	0	0	3	3

VERTICALS – IV (AUTOMATION)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAV41	Power Electronics	PEC	3	0	0	3	3
2	U23RAV42	Object OrientedProgramming in C++	PEC	3	0	0	3	3
3	U23RAV43	Computer Architecture andOrganisation	PEC	3	0	0	3	3
4	U23RAV44	Virtual Instrumentation	PEC	3	0	0	3	3
5	U23RAV45	Industrial NetworkProtocols	PEC	3	0	0	3	3
6	U23RAV46	Motion Control System	PEC	3	0	0	3	3
7	U23RAV47	Total integrated Automation	PEC	3	0	0	3	3
8	U23RAV48	Digital Twin and Industry5.0	PEC	3	0	0	3	3

OPEN ELECTIVES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23RAO11	Industrial Robotics and Material Handling Systems	OE	3	0	0	3	3
2	U23RAO12	Elements of Industrial Automation System	OE	3	0	0	3	3
3	U23RAO13	Robotics in Agriculture	OE	3	0	0	3	3
4	U23RAO14	Foundation of Robotics	OE	3	0	0	3	3
5	U23RAO15	Smart Robotics Technology	OE	3	0	0	3	3

SUMMARY

SL. NO.	SubjectArea	Credits persemester								Credits Total	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities and Social Sciences	5	4	-	-	-	-	2	-	11	**6.586**
2	Basic Sciences	12	8	4	-	-	-	-	-	24	**14.371**
3	Engineering Sciences	5	13	6	2	-	-	-	-	26	**15.568**
4	Professional Core	-	-	13	21	10	8	8	-	60	**35.928**
5	Professional Elective	-	-	-	-	9	6	3	6	24	**14.371**
6	Open Elective	-	-	-	-	-	3	3	-	6	**3.592**
7	Employability Enhancement Courses	-	-	-	-	1	3	2	10	16	**9.580**
	Total	**22**	**25**	**23**	**23**	**20**	**20**	**18**	**16**	**167**	**100**

U23HST11	COMMUNICATIVE ENGLISH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To enhance students listening ability for academic and Professional purposes.
2.	To learn to use basic grammatical structures in suitable contexts
3.	To help students acquire the ability to speak effectively in English in real - life situations.
4.	To help learners use language effectively in professional contexts.
5.	To develop students ability to read and write complex texts, summaries, articles, definitions, Paragraph user manuals.

UNIT I	INTRODUCTION TO EFFECTIVE COMMUNICATION	9

Define communication. Kinds of communication. Quintessential of communication in technical progression. Key characteristics of an effective communicator- listening, attitude modification, way of response with appropriate language, tone modulation.

Listening- Listening to TV news, Guest lectures. Speaking- Answering the Questions.

Reading - Reading brochures and technical magazines (technical context), telephone messages / social media messages relevant to technical contexts and emails, **Writing**-Reading comprehension, Parts of Speech.

UNIT II	READING QUEST	9

Listening- listening and responding to video lectures/talks. **Speaking**- Day today conversations. **Reading** –Edison of India-GD Naidu "The Great Inventor". **Writing-** Emails / Informal Letters - Inviting, Congratulating & Thanking, Punctuations.

UNIT III	LANGUAGE RESOURCE GROWS CRITICAL JUDGEMENT	9

Listening- listening to specific task-focused audio tracks. Speaking- summary of Robert Frost "Stopping by woods on a snowy evening". Reading – Reading advertisements, gadget reviews; user manuals. Writing – Essay Writing: Analytical essay: Narrative Essay, Developing Hints, Usage of tenses in sentence formation. Voices.

UNIT IV	LANGUAGE IN LIFE SKILL	9

Listening- Listening to speech of Great Scholars. Speaking- mechanics of presentation. **Reading** – Newspaper articles, power point presentation. **Writing** – Checklist, Jumbled sentences-Rearrange the sentences in correct order, WH-Questions-Form questions by using statements, Prefixes and Suffixes.

UNITV	IMPROVING SPEAKING &READING	9

Listening- listening to situational based dialogues; **Speaking**- Stating intention to do something- Expressing opinion-asking people to repeat themselves**. Reading** – Summary of O.Henry's "The last Leaf". **Writing** – Dialogue Writing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to:	
CO1 :	Remember appropriate words in a situational conversation.
CO2 :	Gain understanding of basic grammatical structures and use them in right context.
CO3 :	Read and infer the denotative and connotative meanings of technical texts.
CO4 :	Write Dialogue, Letter and paragraphs on various topics.
CO5 :	Make the students prepare effective notes for main sources available.
CO6 :	Enhance them to give operational talk.

TEXT BOOKS:	
1.	English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2.	English for Science & Technology Cambridge University Press, 2021. Authored by Dr. VeenaSelvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3.	The Gift of the Magi by O.Henry, McClure,Philips and company.

REFERENCE BOOKS:	
1.	Technical Communication – Principles And Practices By Meenakshi Raman &Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2.	A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3.	English For Technical Communication (With CD) By AyshaViswamohan, Mcgraw Hill Education.
4.	Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5	Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

U23MAT12	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2.	To familiarize the students with differential calculus.
3.	To familiarize the student with functions of several variables.
4.	To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
5.	To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.

UNIT I	MATRICES	9+3

Introduction – Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Cayley Hamilton theorem – Diagonalization of the matrices by Orthogonal Transformations – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II	DIFFERENTIAL CALCULUS	9+3

Limit of a function – Continuity – Derivatives – Differentiation rules – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variable.

UNIT III	MULTIVARIABLE CALCULUS	9+3

Viscous flow: Shear stress, pressure gradient relationship – Flow of viscous fluid through circular pipe – Flow through pipes: Loss of head due to friction – Minor head losses – Hydraulic gradient and Total energy lines – Flow through pipes in series and in parallel – Power transmission through pipes. Dimensional analysis: Buckingham's theorem.

UNIT IV	MULTIPLE INTEGRAL AND THEIR APPLICATIONS	9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals

UNITV	ORDINARY DIFFERENTIAL EQUATIONS	9+3

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients – Method of undetermined coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Use the matrix algebra methods for solving practical problems.
CO2 :	Use both the limit definition and rules of differentiation to differentiate functions.
CO3:	Apply differential calculus tools in solving various application problems.
CO4:	Able to use differential calculus ideas on several variable functions.
CO5:	Apply multiple integral ideas in solving areas, volumes and other practical

	problems.
CO6:	Solve the ordinary differential equations using different techniques for that model engineering problems.

TEXT BOOKS:	
1.	Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2.	Grewal. B.S., "Higher Engineering Mathematics",Khanna Publishers, New Delhi, 44th Edition, 2018.
3.	James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6 , 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].
REFERENCE BOOKS:	
1.	Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2.	GeofreyBoothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2003.
3.	A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd edition, 2017.
4.	Peter Smid, CNC Programming Handbook, Industrial Press Inc.,; Third edition, 2007

U23PHT13	PHYSICS FOR ENGINEERS AND TECHNOLOGISTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To make the students to gain the knowledge in elastics and plastic nature of the materials in the presence and absence of load.
2.	To understand the students to know the application of the sound waves in different fields.
3.	To motivate the students towards the applications of photo electric phenomena.
4.	To know the physical principle of LASER, the working of LASER applications.
5.	To understand the propagation of light in optical fibers and its applications.

UNIT I	ELASTICITY	9

Introduction- Elasticity - plasticity– Hooke's law - relationship between three Modulii of elasticity (Qualitative) – stress & strain diagram and its uses -Poisson's ratio - factors affecting elasticity - twisting ouple of wire - Torsion Pendulum: theory and experiment.

Beam: Internal bending moment – Cantilever: theory and experiment – Young's Modulus: uniform and non – uniform bending (Qualitative) – I-shaped girders- advantages and applications.

UNIT II	ULTRASONICS	9

Introduction – classification of sound- properties of infrasonic, audible and ultrasonics - production: Magnetostriction and Piezoelectric methods – determination of velocity of sound in liquid (Acoustic Grating Method) – general applications – industrial application: Non - Destructive Testing: pulse echo system through transmission and reflection modes. ultrasonic scanning methods – medical application: sonogram.

UNIT III	MODERN PHYSICS	9

Introduction –Black Body Radiation – Classical and Quantum Laws of Black Body Radiation - Photon and its Properties - Wave Particle Duality and Matter waves – De - Broglie Wavelength - Schrodinger's Time Independent and Time Dependent Wave Equations - Physical Significance of The Wave Function. Application: Particle in One Dimensional Box - Normalization Process – Photo Electric Effect – Laws Governing the Photoelectric Effect – Einstein's Formula - Derivation – Applications: Solar Cell – Solar Water Heater – Photo resistor (LDR).

UNIT IV	LASERS	9

Lasers: Introduction - Properties of Laser-Spontaneous and Stimulated Emission Process - Einstein's Theory of Matter Radiation Interaction & A and B Coefficients; Amplification of Light By Population Inversion – Pumping Methods - Types of Lasers: Solid-State Laser (Homo And Hetero Junction Semiconductor Lasers), Gas Laser (CO_2), Applications: Laser Cutting and Welding, LIDAR and Barcode Scanner.

UNITV	FIBER OPTICS AND APPLICATIONS	9

Optical Fiber: Structure - advantages- Principle [TIR]–Propagation Phenomena in optical fiber - Expression For Acceptance Angle and Numerical Aperture – Relation between Refractive Index of Core, Numerical Aperture and Fractional Index Change – Fabrication: Double Crucible Method - Types: Material, Mode, Refractive Index - Applications: Optical Fiber Communication System – fiber optic sensors (Displacement and pressure sensors) – Medical Endoscope

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to:	
CO1 :	Differentiate the elastic and plastic nature of the materials.
CO2 :	Know the experimental techniques in both production and applications of ultrasonic waves.
CO3:	Gain knowledge in the basics of quantum mechanics concepts.
CO4:	Develop new devices based on LASER source.
CO5:	Understand the advantages of optical fiber than metal wire.
CO6:	Demonstrate the some useful experiments based on optical fibre

TEXT BOOKS:	
1.	Dr.P.Mani, "Engineering Physics", Dhanam Publications, 2013.
2.	Dr. G. Senthilkumar, "Engineering Physics", VRB Publishers, 2017.
3.	K. Thyagarajan, AjoyGhatak, "Lasers Fundamentals and Applications" II nd Edition, Springer, 2010.
4.	D.K. Bhattacharya, Poonam Tandon," Engineering Physics", Oxford HED Publishers, 2017

REFERENCE BOOKS:	
1.	Marikani, "Engineering Physics", PHI, New Delhi, 2013.
2.	Engineering Physics – Bhattacharya, Bhaskaran – Oxford Publications, 2012
3.	Modern Physics by R Murugeshan, Kiruthiga, Sivaprasath S Chand Publishing, 2021
4.	Quantum Mechanics by Sathyaprakash, PragatiPrakashan, Meerut, 2016

U23CYT14	CHEMISTRY FOR ENGINEERING & TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To inculcate sound understanding of water quality parameters and water treatment techniques.
2.	To impart knowledge on the basic principles and preparatory methods of nanomaterials.
3.	To introduce the basic concepts and applications of phase rule and composites.
4.	To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
5.	To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I	WATER TREATMENT	9

Water: Sources , impurities, Parameters. Types of water Hardness of water -types – expression of hardness – units – Estimationof hardness of water by EDTA. Desalination - Reverse Osmosis. Boiler troubles: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process

UNIT II	ELECTRO AND NANO CHEMISTRY	9

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf by Poggendorff's compensation principle. Single electrode potential – Nernst equation – reference electrodes -types–Calomel electrode - electrolysis of water.

Nanomaterials: Basics of Nano Chemistry: Distinction between molecules, nanomaterials and bulkmaterials. Preparation of nanomaterials- laser ablation method and Chemical Vapour Deposition(CVD). Application of Nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III	PHASE RULE AND COMPOSITES	9

Phase rule terms with examples. water system; Reduced phase rule Two component system: lead-silver system – Composites, Need, Constitution: Matrix materials, Applications and Reinforcement and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV	FUELS & COMBUSTION	9

Fuels –Classification-Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO2 emission and carbon foot print.

UNITV	ENERGY SOURCES AND STORAGE DEVICES	9

Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy;

Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion- battery; Electric vehicles-working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel

cell; Super capacitors: Storage principle, types and examples.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
At the end of the course the students would be able to:	
CO1 :	Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.
CO2 :	Apply the basic knowledge of Corrosion and various electrodes.
CO3:	Know the economically and new methods of synthesis nano materials.
CO4:	Apply the knowledge of phase rule and composites for material selection requirements.
CO5:	Understand the concepts of suitable fuels for engineering processes and applications.
CO6:	Have the knowledge of different forms of energy resources and apply them for suitable applications in energy sectors.
TEXT BOOKS:	
1.	P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2.	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3.	S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.
4.	Dr.J.Manivel , "Engineering Chemistry" R.K.Publishers, 1st Edition 2022.
REFERENCE BOOKS:	
1.	B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2.	O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3.	Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4.	ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.

U23GET16	ENGINEERING GRAPHICS	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
2.	To expose them to existing national standards related to technical drawings.
3.	Develop proficiency in 2D drafting using drawing tools.
4.	Learn sectional views and assembly drawing techniques.
5.	Enhance visualization skills for improved problem-solving and communication in engineering.

UNIT I	PLANE CURVES AND ORTHOGRAPHIC PROJECTION	6+12

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimension. Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT II	PROJECTION OF POINTS, LINES AND PLANE SURFACE	6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method (polygonal and circular surfaces) inclined to both the planes.

UNIT III	PROJECTION OF SOLIDS	6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES	6+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple solids – Prisms, pyramids cylinders and cones.

UNIT V	ISOMETRIC PROJECTION	6+12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions-Perspective Projection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Identify the significance of graphics in engineering applications.
CO2 :	Project straight lines inclined to both principal planes and determine true lengths and inclinations.
CO3:	Apply orthographic projection techniques to project solids.
CO4:	Apply the principles of development to prisms, pyramids, cylinders, and cones.
CO5:	Combine two solid objects in simple vertical positions using isometric projection.
CO6:	Utilize the isometric scale effectively.

TEXT BOOKS:	
1.	Grewal B.S., "Higher Engineering Mathematics",44th Edition, KhanaPublishers, NewDelhi,2018.
2.	KreyszigE,"AdvancedEngineeringMathematics",10thEdition,JohnWiley,NewDelhi,India,2016.

REFERENCE BOOKS:	
1.	Andrews.L.C andShivamoggi.B, "IntegralTransformsforEngineers"SPIE Press,1999.
2.	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3.	James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
4.	Narayanan. S., ManicavachagomPillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5.	Ramana.B.V.,"HigherEngineeringMathematics",McGrawHillEducation Pvt.Ltd,NewDelhi,2018.
6.	Wylie.R.C.andBarrett.L.C.,"AdvancedEngineeringMathematics"TataMcGrawHillEducation Pvt.Ltd,6thEdition,NewDelhi,2012.

U23GE3152	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT I	LANGUAGE AND LITERATURE	3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II	HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE	3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils

UNIT III	FOLK AND MARTIAL ARTS	3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV	THINAI CONCEPT OF TAMILS	3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNITV	CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE	3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL: 15 PERIODS

TEXT BOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2.	கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3.	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5.	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6.	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

U23BSP11	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To learn the proper use of various kinds of physics laboratory equipment.
2.	To learn how data can be collected, presented and interpreted in a clear and concise manner.
3.	To learn problem solving skills related to physics principles and interpretation of experimental data.
4.	To determine error in experimental measurements and techniques used to minimize such error.
5.	To make the student as an active participant in each part of all lab exercises.
6.	To inculcate experimental skills to test basic understanding of water quality parameters, as, acidity, alkalinity, chloride.
7.	To Induce the students to analyze the hardness of water
8.	To induce the students to familiarize with electro analytical techniques such as, pH metry, conductometry in the determination of impurities in aqueous solutions.

LIST OF EXPERIMENTS

1.	Torsion pendulum - Determination of rigidity modulus of wire and moment of inertia of regular disc.
2.	Non - Uniform bending–Determination of Young's modulus.
3.	Laser – (i) Determination of the wavelength of the laser using grating. (ii) Determination of size of the particles using laser source.
4.	Air wedge – Determination of thickness of a thin sheet/wire.
5.	Determination of Band gap of a semiconductor using PN junction kit.
6.	To study the V-I Characteristics of Light Dependent Resistor (LDR).
7.	Determination of types and amount of alkalinity in water sample.
8.	Determination of total, temporary & permanent hardness of water by EDTA method.
9.	Determination of chloride content of water sample by Argentometric method.
10.	Determination of strength of given hydrochloric acid using pH meter.
11.	Determination of strength of acids in a mixture of acids using conductivity meter.
12.	Conductometric titration of barium chloride against sodium sulphate (precipitation titration)

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Torsion pendulum set up (Metal Disc, Symmetrical Mass(2x100g), Stop Clock, Screw Gauge)	**5**
2.	Non – Uniform bending set up (Travelling Microscope, Knife Edges, Weight Hanger with Mass(5x50g), Screw Gauge, Vernier Caliper, Meter Scale)	**5**
3.	Laser set up (Semiconductor Laser, Screen, Grating Stand, Wooden Stand	**5**

	With Meter Scale)	
4.	Air wedge (Air Wedge Set Up, Travelling Microscope, Sodium Vapour Lamp, Transformer)	**5**
5.	Band gap of a semiconductor (PN Junction Kit, Thermometer, Heater, Beaker, Oil)	**5**
6.	Light Dependent Resistor (Power Suppy, Voltmeter, Ammeter, LDR, Bulb, Resistors)	**5**
7.	PH meter	**5**
8.	Conductivity meter	**10**
9.	Common Apparatus(Pipette, Burette, Conical Flask, Porcelain tile, Dropper)	**15**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand the functioning of various physics laboratory equipment.
CO2 :	Observe and tabulate experimental data.
CO3:	Solve problems individually and collaboratively.
CO4:	Analyse the quality of water samples with respect to their acidity, alkalinity
CO5:	Determine the amount of hardness in the water
CO6:	Analyse quantitatively the impurities in solution by electro analytical techniques

U23HSP12	ENGLISH LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To improve the communicative competence of learners.
2.	To help learners use language effectively in academic /work contexts.
3.	To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
4.	To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
5.	To use language efficiently in expressing their opinions via various media.

LIST OF EXPERIMENTS

1	Listening for general information-specific details.
2	Conversation: Introduction to classmates.
3	Speaking - making telephone calls-Self Introduction.
4	Talking about current and temporary situations & permanent and regular situations.
5	Listening to podcasts, anecdotes / stories / event narration.
6	Event narration; documentaries and interviews with celebrities.
7	Events-Talking about current and temporary situations & permanent and regular situations.
8	Engaging in small talk.
9	Describing requirements and abilities- Picture description.
10	Discussing and making plans.
11	Talking about tasks- progress- positions -directions of movement.
12	Talking about travel preparations and transportation.
13	Listening to debates/ discussions.
14	Making prediction talking about a given topic.
15	Describing processes.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**

8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Identify and comprehend complex academic texts.
CO2 :	Interpret accurately and fluently in formal and informal communicative contexts.
CO3:	Demonstrate their opinions effectively in both oral and written medium of communication.
CO4:	Plan travelogue and construct paragraphs on various aspects.
CO5:	Develop journal reading skills and small talk.
CO6:	Utilizing technical terms and making power point presentations.

U23GEP14	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1	Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planning; making joints in wood materials used in common house hold wood work.
2	Wiring various electrical joints in common household electrical wire work.
3	Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts;
4	Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.
5	Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.

GROUP – A (CIVIL AND MECHANICAL)

PART I	**CIVIL ENGINEERING PRACTICES PLUMBING WORK:**	**30**
	a. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household. b. Preparing plumbing line sketches. c. Laying pipe connection to the suction side of a pump d. Laying pipe connection to the delivery side of a pump. e. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.	
	WELDING WORK: a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding. b) Practicing gas welding. **BASIC MACHINING WORK:** a) Turning b) Drilling c) Tapping **ASSEMBLY WORK:** a) Assembling a centrifugal pump. b) Assembling a household mixer. **SHEET METAL WORK:** a) Making of a square tray **WOOD WORK:** a. Sawing, b. Planing and c. Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.	
PART II	**ELECTRICAL & ELECTRONICS**	**30**
	1. Residential house wiring using switches, fuse, indicator, lamp and energy meter. 2. Fluorescent lamp wiring. 3. Stair case wiring 4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.	

	5. Measurement of energy using single phase energy meter. 6. Measurement of resistance to earth of an electrical equipment. **ELECTRONICS** 1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR. 2. Study of logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering practice – Components Devices and Circuits Using general purpose PCB. 5. Measurement of ripple factor of HWR and FWR.

TOTAL = 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15Sets.
2. Carpentry vice (fitted to work bench) 15Nos.
3. Standard woodworking tools 15 Sets.
4. Models of industrial trusses, door joints, furniture joints 5each
5. Power Tools: (a) Rotary Hammer 2 Nos (b) Demolition Hammer 2 Nos (c) Circular Saw 2 Nos (d) Planer 2 Nos (e) Hand Drilling Machine 2 Nos (f) Jigsaw 2Nos

MECHANICAL

Arc welding transformer with cables and holders 5 Nos.

1. Welding booth with exhaust facility 5Nos.
2. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5Sets.
3. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2Nos.
4. Centre lathe 2Nos.
5. Hearth furnace, anvil and smithy tools 2Sets.
6. Moulding table, foundry tools 2Sets.
7. Power Tool: Angle Grinder 2Nos
8. Study-purpose items: centrifugal pump, air-conditioner One each

ELECTRICAL

1. Assorted electrical components for house wiring 15Sets
2. Electrical measuring instruments 10Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1No.
5. Power Tools:
   a) Range Finder 2Nos
   b) Digital Live-wire detector 2Nos

ELECTRONICS

1. Soldering guns 10Nos.
2. Assorted electronic components for making circuits 50Nos.
3. Small PCBs 10Nos.
4. Multimeters 10Nos.

Study purpose items: Telephone, FM radio, low-voltage power supply.

COURSE OUTCOMES:	
Upon completion of this course, the students will be able to:	
CO1 :	Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
CO2 :	Wire various electrical joints in common household electrical wire work.
CO3:	Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common Household equipment; Make a tray out of metal sheet using sheet metal work.
CO4:	Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.
CO5:	Apply fundamental engineering principles to analyze and solve real-world problems.
CO6:	Demonstrate proficiency in using engineering tools and equipment.

U23HST21	PROFESSIONAL COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To engage learners in meaningful language activities to improve their reading and writing skills.
2.	To learn various reading strategies and apply in comprehending documents in professional context.
3.	To help learners understand the purpose, audience, contexts of different types of writing.
4.	To enable students write letters and reports effectively in formal and business situations.
5.	To demonstrate an understanding of job applications and interviews for internship and placements.

UNIT I	PREPARATORY DOCUMENTATIONS	9

Listening- Listening to formal conversations and Participating**. Speaking-** speaking about one's family. **Reading –** Summary of W.W Jacobs "The monkey's paw". **Writing –** Subject verb Agreement, Numerical -Adjectives, Kinds of sentences**,** Writing reviews (book / film),writing Instructions, Writing Recommendation.

UNIT II	LECTURA ENRICHMENT AND PASSAGE COMPOSE	9

Listening- listening to lectures on academic topics; **Speaking-** Asking for and giving directions. **Reading -** Reading longer technical texts; **Writing -** Compound words, Homophones and Homonyms, Cause and Effect expressions. Essay Writing, Writing Letter to the Editor (complaint, acceptance, Requesting, Thanking).

UNIT III	ANALYTICAL SKILL	9

Listening- Watching videos/documentaries and responding to questions based on them. **Speaking –**Speaking about ones favorite place**. Reading –** Summary of the poem – John keats "Ode to a Nightingale". **Writing-** Purpose statement, Extended Definitions. Writing Job/ Internship application – Cover letter & Resume.

UNIT IV	REPORT WRITING	9

Listening- Listening to class room lectures/talks on engineering/technology. **Speaking–** Introduction to technical presentations. **Reading –** Newspaper articles; **Writing –** Comparative Adjectives Direct and Indirect speech**.** Report Writing- Fire Accident Report, Road Accident, Feasibility Report).

UNITV	ENABLING LINGUA IDEALITY & INFORMATION	9

Listening- TED/Ink talks. **Speaking –** Making presentation on a given topic. **Reading –**Company profiles, Statement of Purpose, (SOP), **Writing –** Relative Clauses, If conditions, Cause and Effect. Chart Interpretations - Bar Chart, Pie Chart, Flow Chart & Tables.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Compare and contrast products and ideas in technical texts.
CO2 :	Identify cause and effects in events, industrial processes through technical texts.
CO3 :	Analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.
CO4 :	Motivate students to write reports and winning job applications.
CO5 :	Recall and comprehend different discourses and genres of texts.
CO6 :	Making the students to become virtuous presenters.

TEXT BOOKS:	
1.	English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2.	English for Science & Technology Cambridge University Press 2021.
3.	Authored by Dr. VeenaSelvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:	
1.	Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2.	Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3.	Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4.	Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5.	Developing Communication Skills by Krishna Mohan, Meera Bannerji-Macmillan India Ltd. 1990, Delhi.

U23MAT22	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1.	This course aims at providing the necessary basic concepts of a few statistical tools and give procedures for solving different kinds of problems occurring in engineering and technology.
2.	To acquaint the knowledge of classifications of design of experiments in the field of agriculture.
3.	To introduce the basic concepts of solving algebraic and transcendental equations.
4.	To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
5.	To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I	TESTING OF HYPOTHESIS	12

Introduction – Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II	DESIGN OF EXPERIMENTS	12

Introduction – Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT III	SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	12

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method — Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen Value of a matrices by power method and jacobi's method for Symmetric matrices.

UNIT IV	INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION	12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V	NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	12

Single step methods : Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge– Kutta method for solving first order differential equations – Multi step methods : Milne's and Adams Bash forth predictor corrector methods for solving first order differential equations.

TOTAL:60 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to:	
CO1 :	Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2 :	Apply the basic concepts of classifications of design of experiments in the field of agriculture.
CO3:	Solve the algebraic and transcendental equations.
CO4:	Understand the knowledge of numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
CO5:	Solve the ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
CO6:	Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

TEXT BOOKS:	
1.	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2.	Johnson , R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES BOOKS :	
1.	Burden,R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2.	Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi , 8th Edition, 2014.
3.	Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4.	Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi,12th Edition, 2020.
5.	Spiegel.M.R.,Schiller.J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.

U23GET15	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the basics of algorithmic problem solving.
2.	To learn to solve problems using Python conditionals and loops.
3.	To define Python functions and use function calls to solve problems.
4.	To use Python data structures - lists, tuples, dictionaries to represent complex data
5.	To do input/output with files in Python.

UNIT I	COMPUTATIONAL THINKING AND PROBLEM SOLVING	9+3

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II	DATA TYPES, EXPRESSIONS, STATEMENTS	9+3

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III	CONTROL FLOW, FUNCTIONS, STRINGS	9+3

Conditionals: Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, GCD, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV	LISTS, TUPLES, DICTIONARIES	9+3

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation

UNITV	FILES, MODULES, PACKAGES	9+3

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL: 60 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1:	Develop algorithmic solutions to simple computational problems
CO2:	Develop and execute simple Python programs
CO3:	Develop simple Python programs using conditionals and loops for solving problems
CO4:	Explain the Concept of Files and exceptions
CO5:	Develop simple Python programs for Read and write data from/to files in Python programs
CO6.	Explain the concept of exceptions and handling
TEXT BOOKS:	
1.	Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016
2.	Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017
REFERENCE BOOKS:	
1.	Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2.	G Venkatesh and MadhavanMukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3.	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4.	Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.

U23PHT23	APPLIED MATERIALS SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To make the students to understand the basics of crystallography and its importance in studying materials properties.
2.	To understand the electrical properties of materials including free electron theory, applications.
3.	To expand their knowledge in applications of magnetic and superconducting materials.
4.	Toinstillknowledgeonphysicsofsemiconductors,determinationofchargecarriersanddevice applications.
5.	To inculcate an idea of significance of new materials, nanostructures ensuing nano device applications.

UNIT I	CONDENSED MATTER PHYSICS	9

Introduction - Lattice - Unit Cell - Seven Crystal Systems -Bravai's Lattices - Lattice Planes - Calculation of Number of Atoms per Unit Cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP Structures. Miller Indices – Derivation for Inter-Planar Spacing in terms of Miller Indices-Crystal Growth Techniques: Melt Growth Technique (Bridgman and Czochralski Techniques).

UNIT II	CONDUCTING AND INSULATING MATERIALS	9

Conducting Materials: Classical Free Electron Theory: Postulates – Derivation of Electrical Conductivity and Thermal Conductivity- Derivation. Wiedemann-Franz Law and Its Verification- Merits and Demerits of Classical Free Electron Theory. Density of States – Carrier Concentration in Metals.

Insulating Materials: Types of Polarization Mechanisms - Langevin- Debye Equation - Internal Field – Clausius - Mossotti Relation – Applications of Insulating Materials.

UNIT III	MAGNETIC AND SUPERCONDUCTING MATERIALS	9

Magnetic Materials: Dia, Para and Ferromagnetic Materials and Its Properties – Ferromagnetic Domains – Wiess Theory of Ferromagnetism – Hysteresis - B-H Curve Studies – Soft and Hard Magnetic Materials- Applications.

Superconducting Materials: Properties – Type I and Type II Superconductors – London equations – Applications: Magnetic Levitated Train – Magnetic Resonance Imaging.

UNIT IV	PHYSICS OF SEMICONDUCTOR	9

Introduction – Properties - IntrinsicSemiconductors–EnergyBandDiagram–DirectandIndirectBandGapSemiconductors–CarrierConcentrationinIntrinsicSemiconductors–ExtrinsicSemiconductors - Carrier Concentration in N-Type & P-Type Semiconductors – Variation ofCarrier Concentration with Temperature – Carrier Transport in Semiconductors: Drift, Mobility and Diffusion– Hall EffectAndDevices.

UNIT V	MODERN ENGINEERING MATERIALS	9

Shape Memory Alloys – Structures – Properties – Applications. Metallic Glasses – Preparation and

Applications. Ceramics – Types - Properties and Applications.
Nanomaterials – Types – Properties and Applications – Preparation Techniques: Electrodeposition – Pulsed Laser Deposition. CNT – Structure – Types – Properties – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Know basics of crystallography and its importance for varied materials properties.
CO2 :	Familiarizewiththeoriesofelectricalandthermalconductionissolids,basicquantum mechanics,andenergybands.
CO3:	Gain knowledge on the magnetic and superconductor properties of materials and their applications.
CO4:	Acquire knowledge on basics of semiconductor physics and its applications in various devices.
CO5:	Get knowledge on newly developed materials in micro and nano scale.
CO6:	Understand the different structures of CNT in Nano range

TEXT BOOKS:

1.	Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
2.	Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley(India), 2007.
3.	G.W.Hanson.FundamentalsofNanoelectronics.PearsonEducation(IndianEdition),2009.
4.	Dr. P. Mani, “Physics for Electronics Engineering” Dhanam Publications, 2017.
5.	Dr. G. Senthilkumar, “Engineering Physics II” VRB Publishers, 2013.

REFERENCE BOOKS:

1.	R.Balasubramaniam, Callister’s Materials Science and Engineering. Wiley (Indian Edition), 2014.
2.	Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3.	S. Rajivgandhi, Dr. I. Cicil Ignatius & A. Ravikumar, “ Engineering Physics II”, RK Publications, 2023
4.	Robert F. Pierret, Semiconductor Device Fundamentals, Pearson, 2006.
5.	Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

U23EET24	BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	The basics of electric circuits and analysis.
2.	The basics of working principles and application of electrical Machines.
3.	The knowledge in Analog devices and their characteristics.
4.	Educating the fundamental concepts of linear integrated circuits.
5.	The functional elements and working of measuring instruments.

UNIT I	ELECTRICAL CIRCUITS	9

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state) Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

UNIT II	ELECTRICAL MACHINES	9

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

UNIT III	ANALOG ELECTRONICS	9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters

UNIT IV	LINEAR INTEGRATED CIRCUITS	9

Ideal OP-AMP characteristics, Basic applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-S/H circuit, D/A converter (R- 2R ladder), A/D converters- Flash type ADC using OP-AMPS . Functional block, characteristics of 555 timer– Astable multi-vibrator mode.

UNITV	MEASUREMENTS AND INSTRUMENTATION	9

Functional elements of an instrument, Standards and calibration, Operating Principle , types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT,DSO- Block diagram- Data acquisition.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Compute the electric circuit parameters for simple problems
CO2 :	Explain the working principle of electrical machines
CO3:	Explain the applications of electrical machines
CO4:	Analyze the characteristics of analog electronic devices

CO5:	Explain the basic concepts of linear integrated circuits
CO6:	Explain the operating principles of measuring instruments.

TEXT BOOKS:	
1.	D P Kothari and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, Second Edition, 2020.
2.	Allan S Moris, "Measurement and Instrumentation Principles", Third Edition, Butterworth Heinemann, 2001.
3.	S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4.	James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
REFERENCE BOOKS:	
1.	Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
2.	A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi,January 2015.
3.	Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017

U23GE3252	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT I	WEAVING AND CERAMIC TECHNOLOGY	3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II	DESIGN AND CONSTRUCTION TECHNOLOGY	3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III	MANUFACTURING TECHNOLOGY	3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and goldCoins as source of history - Minting of Coins – Beads making-industries Stone beads –Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV	AGRICULTURE AND IRRIGATION TECHNOLOGY	3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society

UNITV	SCIENTIFIC TAMIL & TAMIL COMPUTING	3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2.	கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3.	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4.	பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5.	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6.	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7.	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8.	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9.	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

U23EEP23	BASIC ELECTRICAL, ELECTRONICS ENGINEERING AND MEASUREMENTS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Using experimental methods to verify the Ohm's.
2.	Analysing the behaviour of digital devices.
3.	Conducting load tests on electrical machines
4.	Gaining practical experience in characterizing electronic devices
5.	Using DSO for measurements

LIST OF EXPERIMENTS

1.	Verification of ohms and Kirchhoff's Laws.
2.	Load test on DC Shunt Motor.
3.	Load test on Self Excited DC Generator
4.	Load test on Single phase Transformer
5.	Load Test on Induction Motor
6.	Experiment on Transistor based application circuits (Inverting and non-inverting amplifier or switching circuits)
7.	Experiments on ADC.
8.	Experiments on 555 timer
9.	Study on function of DSO.
10.	Measurement of Amplitude, Frequency, Time, Phase Measurement using DSO.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	DC Regulated Power supply (0 - 30 V variable)	1
2.	DC shunt generator (0- 300V)	1
3.	Wattmeter – 300V, 30 A	1
4.	Single phase Induction motor	1
5.	Op-Amp	1
6.	Transistor	1
7.	Resistors	1
8.	Function Generator 1 KHz	1
9.	IC 555 Time	1
10.	Ammeter MC	As required
11.	Voltmeter MC	As required
12.	Rheostats	As required
13.	Tachometer	As required
14.	Connecting wires	As required

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Use experimental methods to verify the Ohm's Laws.
CO2 :	Use experimental methods to verify Kirchhoff's Laws.

CO3:	Analyze experimentally the load characteristics of electrical machines
CO4:	Analyze the characteristics of basic electronic devices
CO5:	Analyze the behavior of digital devices.
CO6:	Use DSO to measure the various parameters

U23HSP22	COMMUNICATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1.	To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
2.	To be able to communicate effectively through writing.
3.	Encouraging plan designing and decision making.
4.	Understanding and writing technical instruction.
5.	To understand the value of letter writing with correct format.

LIST OF EXPERIMENTS:

1.	Speaking-Role Play Exercises Based on Workplace Contexts.
2.	Talking about competition.
3.	Discussing progress toward goals-talking about experiences.
4.	Discussing likes and dislikes.
5.	Discussing feelings about experiences.
6.	Discussing imaginary scenarios.
7.	Writing short essays.
8.	Speaking about the natural environment.
9.	Describing communication system.
10.	Describing position and movement- explaining rules.
11.	Understanding technical instructions-Writing: writing instructions.
12.	Speaking: describing things relatively-describing clothing.
13.	Discussing safety issues (making recommendations) talking about electrical devices.
14.	Describing controlling actions.
15.	Writing a job application (Cover letter + Resume).

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:	
At the end of the course the students would be able to:	
CO1 :	Distinguish their technical competency through language skill.
CO2 :	Predict context effectively in-group discussions held in a formal / semi-formal discussions.
CO3:	Understanding candidates' key characteristics.
CO4:	Finding personality traits by sharing and comparing thoughts and ability.
CO5:	Understanding the value of ethics.(rules and regulations).
CO6:	Construct emails and effective job applications**.**

U23HSP13	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the problem-solving approaches.
2.	To learn the basic programming constructs in Python.
3.	To practice various computing strategies for Python-based solutions to real world problems.
4.	To use Python data structures - lists, tuples, dictionaries.
5.	To do input/output with files in Python.
6.	To understand the problem-solving approaches.

LIST OF EXPERIMENTS

1.	Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2.	Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3.	Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4.	Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5.	Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6.	Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7.	Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters)
8.	Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9.	Implementing real-time/technical applications using File handling. (Copy from one file to another, word count, longest word)
10.	Implementing real-time/technical applications using Exception handling. (Divide by zero error, voter's age validity, student mark range validation)
11.	Exploring Pygame tool. 12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS		
Sl.No.	**Name of the Equipment**	**Quantity**
1.	INTEL based desktop PC with min. 8GB RAM and 500 GB HDD, 17" or higher TFT Monitor, Keyboard and mouse	30
2.	Windows 10 or higher operating system / Linux Ubuntu 20 or higher	30
3.	PyCharm / IDLE / Spyder /	30
COURSE OUTCOMES:		
At the end of the course the students would be able to		
CO1:	Develop algorithmic solutions to simple computational problems.	
CO2:	Develop and execute simple Python programs	
CO3:	Build programs in Python using conditionals and loops for solving problems	
CO4:	Apply functions to decompose a Python program	
CO5:	Construct compound data using Python data structures	
CO6:	Utilize Python packages in developing software applications	

U23MAT31	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the basic concepts of PDE for solving standard partial differential equations
2.	To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
3.	To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
4.	To acquaint the student with Fourier transform techniques used in wide variety of situations.
5.	To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	9

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II	FOURIER SERIES	9

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV	FOURIER TRANSFORMS	9

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNITV	Z - TRANSFORMS AND DIFFERENCE EQUATIONS	9

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z – transforms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand how to solve the given standard partial differential equations.
CO2 :	Solve differential equations using Fourier series analysis which plays a vital role in engineering applications

CO3:	AppreciatethephysicalsignificanceofFourierseriestechniquesinsolvingoneandtwodimensionalheatflowproblemsandonedimensionalwaveequations.
CO4:	Understandthemathematicalprinciplesontransformsandpartialdifferentialequations wouldprovidethemtheabilitytoformulateandsolvesomeofthephysicalproblemsofengineering.
CO5:	UsetheeffectivemathematicaltoolsforthesolutionsofpartialdifferentialequationsbyusingZtransformtechniquesfordiscrete time systems.
CO6:	Use the method of Laplace Transform to solve initial value problem for Linear differential equations with constant coefficients.

TEXT BOOKS:

1.	Grewal B.S., "Higher Engineering Mathematics",44th Edition, Khana Publishers, NewDelhi,2018.
2.	KreyszigE,"AdvancedEngineeringMathematics",10thEdition,JohnWiley,NewDelhi,India,2016.

REFERENCE BOOKS:

1.	Andrews. L.C and Shivamoggi.B, "Integral Transforms for Engineers" SPIE Press,1999.
2.	Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3.	James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
4.	Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5.	Ramana.B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, NewDelhi, 2018.
6.	Wylie.R.C.andBarrett.L.C.,"AdvancedEngineeringMathematics"TataMcGrawHillEducation Pvt.Ltd,6thEdition,NewDelhi,2012.

U20RAT31	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To know the properties of fluids and concept of control volume are studied
2.	To knowledge in Fluid Properties and Statics
3.	To understand the importance of various types of flow in pumps.
4.	To learn about the flows in fluid, Viscous flows and flow through pipes
5.	To understand the importance of dimensional analysis

UNIT I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9

Units and dimensions - Properties of fluids - mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity – Euler's and Bernoulli's equation of motion.

UNIT II	FLOW THROUGH PIPES	

Types of flow – Laminar, turbulent and transient - Darcy Weisbach equation – friction factor – Major and minor losses – Hydraulic and energy gradient lines – Boundary layer concepts.

UNIT III	DIMENSIONAL ANALYSIS	9

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude – Dimensionless parameters- application of dimensionless parameters.

UNIT IV	TURBINES	9

Theory of rotodynamic machines – Classification of turbines – Working principles – Pelton wheel – Francis turbine – Kaplan turbine – Work done by water on the runner – Draft tube – Specific speed.

UNITV	PUMPS	9

Classification of pumps – Centrifugal pumps – Working principle – Heads and efficiencies – Work done by the impeller – Reciprocating pump - working principle – Indicator diagram – Rotary pumps.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Understand the properties and behaviour in static conditions. Also, to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
CO2 :	Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also, to understand the concept of boundary layer and its thickness on the flat solid surface.
CO3:	Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
CO4:	Explain the working principles of various turbines and design the various types of turbines.
CO5:	Explain the working principles of centrifugal, reciprocating and rotary pumps and

	design the centrifugal and reciprocating pumps.
CO6:	Understand the importance of fluid in industrial applications.
TEXT BOOKS:	
1.	M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014
2.	Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2007
REFERENCE BOOKS:	
1.	Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.
2.	Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
3.	Muhammad Ali Mazidi & amp; Janice GilliMazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.
4.	R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013

U23MET21	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To Learn the use scalar and vector analytical techniques for analysing forces in statically determinate structures.
2.	To introduce the equilibrium of rigid bodies, vector methods and free body diagram.
3.	To study and understand the distributed forces, surface, loading on beam and intensity.
4.	To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5.	To develop basic dynamics concepts – force, momentum, work and energy.

UNIT I	STATICS OF PARTICLES	9

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II	EQUILIBRIUM OF RIGID BODIES	9

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

UNIT III	DISTRIBUTED FORCES	9

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus - Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV	FRICTION	9

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

UNITV	DYNAMICS OF PARTICLES	9

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse

and Momentum, Impact of bodies.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Illustrate the vector and scalar representation of forces and moment
CO2 :	Analyse the rigid body in equilibrium
CO3:	Evaluate the properties of distributed forces
CO4:	Determine the friction and the effects by the laws of friction
CO5:	Calculate dynamic forces exerted in rigid body
CO6:	Apply the concepts of mechanics and work in force analysis
TEXT BOOKS:	
1.	Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12thEdition, 2019.
2.	Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.
REFERENCE BOOKS:	
1.	Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2.	Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3.	Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.

U23RAT32	DIGITAL ELECTRONICS AND MICROPROCESSOR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To present the Digital fundamentals, Boolean algebra and its applications in digital systems.
2.	To familiarize with the design of various combinational digital circuits using logic gates.
3.	To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits.
4.	To explain the various semiconductor memories and related technology.
5.	To introduce the electronic circuits involved in the making of logic gate.

UNIT I	DIGITAL FUNDAMENTALS	9

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine- McCluskey method of minimization.

UNIT II	COMBINATIONAL & SYNCHRONOUS SEQUENTIAL CIRCUITS	9

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder -Multiplexer, Demultiplexer, Decoder, Priority Encoder. Flip flops – SR, JK, T, D, design of clocked sequential circuits – Design of Counters- Shift registers, Universal Shift Register.

UNIT III	ASYNCHRONOUS SEQUENTIAL CIRCUITS AND MEMORY DEVICES	9

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits. Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA).

UNIT IV	8085 PROCESSOR	9

Hardware Architecture, pin diagram – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.

UNITV	PROGRAMMING PROCESSOR	9

Instruction - format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions – stack -8255 architecture and operating modes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	State the fundamental operating concepts behind digital logic circuits and microprocessors.
CO2 :	Recognize the use of various digital logic circuits and sub units in microprocessors.

CO3:	Interpret the information flow in digital logic circuits and the architectures of microprocessors.
CO4:	Design the DLC and Microprocessor for the standard applications.
CO5:	Create the circuits using DLC and Microprocessor for given applications.
CO6:	Fundamental programing of Microprocessor.

TEXT BOOKS:	
1.	M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014
2.	Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2007
REFERENCE BOOKS:	
1.	Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.
2.	Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
3.	Muhammad Ali Mazidi& Janice GilliMazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.
4.	R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013

U20RAT34	ELECTRICAL DRIVES AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To familiarize a relay and power semiconductor devices
2.	To get a knowledge on drive characteristics
3.	To obtain the knowledge on DC motors and drives.
4.	To obtain the knowledge on AC motors and drives.
5.	To obtain the knowledge on Stepper and Servo motor

UNIT I	RELAY AND POWER SEMI-CONDUCTOR DEVICES	9

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, MOSFET, IGBT -: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits

UNIT II	DRIVE CHARACTERISTICS	9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.

UNIT III	DC MOTORS AND DRIVES	9

DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations- characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications.

UNIT IV	AC MOTORS AND DRIVES	9

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

UNITV	STEPPER AND SERVO MOTOR	9

Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation-Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Recognize the principles and working of relays, drives and motors
CO2 :	Explain the working and characteristics of various drives and motors.
CO3:	Apply the solid state switching circuits to operate various types of Motors and Drivers
CO4:	Interpret the performance of Motors and Drives.
CO5:	Suggest the Motors and Drivers for given applications.
CO6:	Interpret the applications of stepper and servo motor.

TEXT BOOKS:

1.	Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2.	Mehta V.K. &Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.
REFERENCE BOOKS:	
1.	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2.	Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
3.	Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

U20RAT34	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To study the concepts and basic mechanics of metal cutting and the factors affecting machinability
2.	To learn working of basic and advanced turning machines.
3.	To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4.	To study the basic concepts of CNC of machine tools and constructional features of CNC.
5.	To learn the basics of CNC programming concepts to develop the part programme for Machine centre and turning centre.

UNIT I	MECHANICS OF METAL CUTTING	9

Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II	TURNING MACHINES	9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle.

UNIT III	RECIPROCATING MACHINE TOOLS	9

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods.

UNIT IV	CNC MACHINES	9

Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features.

UNITV	PROGRAMMING OF CNC MACHINE TOOLS	9

Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers– Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Apply the mechanism of metal removal process and to identify the factors involved in improving machinability
CO2 :	Describe the constructional and operational features of centre lathe and other special purpose lathes.

CO3:	Describe the constructional and operational features of reciprocating machine tools.
CO4:	Apply the constructional features and working principles of CNC machine tools.
CO5:	Demonstrate the Program CNC machine tools through planning and setting up CNC machine tools to manufacture a given component.
CO6:	Acquire knowledge on CNC Coding.

TEXT BOOKS:	
1.	Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2009.
2.	Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 3rd edition, 2013.
REFERENCE BOOKS:	
1.	Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2.	GeofreyBoothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2003.
3.	A. B. Chattopadhyay, Machining and Machine Tools, Wiley, 2nd edition, 2017.
4.	Peter Smid, CNC Programming Handbook, Industrial Press Inc.,; Third edition, 2007

	INTERFACING SENSORS WITH ROBOTIC CONTROLLER	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To Understand the basic concepts of Arduino Controller.
2.	To Understand the programming of Arduino Controller.
3.	To get the basic knowledge about various sensors and its application.
4.	To know about interfacing of sensors with robotic controllers.
5.	To interpret the concepts in real time robotic application .

MODULE I	ARDUINO PROGRAMMING	15

Introduction to Embedded systems and Robotics, Arduino Nano hardware basics, Installing Arduino IDE and driver for programming, Digital write for controlling DC load, LED, Using delay functions for precise timing, Digital read for taking input – Push Button, Serial communication – Print message on the serial monitor, Serial communication – Read serial message and control DC load, Digital read serial – Print status of digital input to Serial monitor, Analog read serial – Read voltage from a potentiometer and display on serial monitor, Analog write – Fading an LED using duty cycle adjustment of PWM

MODULE II	SENSOR SPECIFICATIONS & INTERFACING OF SENSORS AND ACTUATORS	15

Locate sensor specifications using the Internet and examine the following sensors' operation Based on those specifications: Temperature sensors, Pressure sensors, Flow sensors, Level sensors Limit switches, Inductive, proximity switches, Capacitive, proximity switches, Hall-effect sensors Photo-electric switches, Fibre-optic, photo-electric sensor.
Interfacing of Sensor: Ultrasonic sensors, IR sensors, Gas sensors, LED
Interfacing of Actuators: DC Motor, Servo motor, Stepper motor.

MODULE III	CASE STUDIES and HANDS ON TRAINING	15

1. Self-balancing Robot
2. Object Detection Robot
3. Line follower Robot

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Explain concepts and scope application of Arduino Controller.
CO2 :	Program in Arduino Controller.
CO3:	Explain the various sensors and its application.
CO4:	Interface the sensors with the robotic controller.
CO5:	Create a working model for a specific task.
CO6:	Apply the concepts in real time robotic application.

U23RAP31	ELECTRICAL DRIVES AND ACTUATORS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics
2.	To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation
3.	To impart the knowledge about Thyrister family.
4.	To impart the knowledge about special machines.
5.	To impart the knowledge about power electronic drives.

LIST OF EXPERIMENTS

1.	Load test on DC Motor
2.	Load test on 3 Phase Induction Motor
3.	Load test on 3 Phase Synchronous Motor.
4.	Rheostat based Speed control of DC motor.
5.	Switching circuits of SCR and TRAIC.
6.	Switching circuits of MOSFET and IGBT.
7.	Gate pulsation generation using PWM signals.
8.	Speed control of DC motor using Power Electronic Drive.
9.	Position and direction control DC servomotor using Power Electronic Drive.
10.	Position, direction and speed control of BLDC and PMDC motors using Power Electronic Drive.
11.	Position, Direction and speed control of stepper Motor.
12.	VFD control of single phase and three-phase induction motor using Power Electronic Drive.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	DC Motor with load	1
2.	3PhaseInductionMotorwithload	1
3.	3PhaseSynchronousMotorwithload	1
4.	Rheostat based Speed control of DC motors with load	1
5.	MOSFET, IGBT, SCR and TRAIC	1
6.	DC motor with speed control Drive	1
7.	DC servomotor with Power Electronic Drive(Position, Direction and speed).	1

8.	BLDCandPMDCmotorswithPowerElectronicDrive(Position,Directionandspeed).	1
9.	Stepper Motor with Power Electronic Drive (Position, Direction and speed).	1
10.	VFD with single phase and three-phase induction motor.	1
11.	Tachometers, voltmeters, ammeters and multimeter.	Each5

COURSE OUTCOMES:	
At the end of the course the students would be able to:	
CO1 :	Practice the basic working of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive.
CO2 :	Demonstrate the control of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive.
CO3:	Analyze the performance of AC, DC motor, stepper motor, servo motor and synchronous motor using power electronic drive
CO4:	Analyse about the switching characteristics
CO5:	Analyse the performance of special machine.
CO6:	Knowledge in power electronics and drive circuits.

U23RAP32	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Selecting appropriate tools, equipment's and machines to complete a given job.
2.	Performing various welding process using GMAW and fabricating gears using gear making machines.
3.	Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analysing the defects in the cast and machined components.
4.	Gain proficiency in lathe machine operations for thread cutting and knurling.
5.	Acquire skills in pattern making and mould preparation for casting.

LIST OF EXPERIMENTS

1.	Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2.	Preparing green sand moulds with cast patterns.
3.	Taper Turning and Eccentric Turning on circular parts using lathe machine.
4.	Knurling, external and internal thread cutting on circular parts using lathe machine.
5.	Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
6.	Drilling and Reaming using vertical drilling machine.
7.	Milling contours on plates using vertical milling machine.
8.	Cutting spur and helical gear using milling machine.
9.	Generating gears using gear hobbing machine.
10.	Generating gears using gear shaping machine.
11.	Grinding components using cylindrical and centerless grinding machine.
12.	Grinding components using surface grinding machine.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Centre Lathes	7 Nos
2.	Shaper	1Nos
3.	Horizontal Milling Machine	1Nos
4.	Vertical Milling Machine	1Nos
5.	Surface Grinding Machin	1Nos
6.	Cylindrical Grinding Machine	1Nos
7.	Radial Drilling Machine	1Nos
8.	Lathe Tool Dynamometer	1Nos
9.	Milling Tool Dynamometer	1Nos

10.	Gear Hobbing Machine	1Nos
11.	Gear Shaping Machine	1Nos
12.	Arc welding transformer with cables and holders	2 Nos
13.	Oxygen and Acetylene gas cylinders, blow pipe and other welding outfit	1Nos
14.	Moulding table, Moulding equipment	2 Nos

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Demonstrate the working of lathe machine.
CO2 :	Interpret the various operations performed in Lathe machines.
CO3:	Identify tool life, tool wear and forces in metal cutting.
CO4:	Choose suitable manufacturing techniques to manufacture different products.
CO5:	Construct to join the metals using arc welding.
CO6:	Make use of different moulding tools, patterns and prepare sand moulds.

U23RAT41	DESIGN OF ROBOT ELEMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the students to the fundamentals of machine design, material selection and to solve the basic design problems.
2.	To learn to derive various parameters for modelling links and joints in a robot.
3.	To learn about Fundamentals of Computer Graphics
4.	To learn and understand curves and surfaces in robot modelling.
5.	To learn to derive various parameters for modelling end-effectors of a robot

UNIT I	FUNDAMENTALS OF MECHANICAL DESIGN	9

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - 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.

UNIT II	DESIGN OF LINKS AND JOINTS	9

Loads and Forces on Links and Joints - Design of solid and hollow shafts - Rigid and flexible couplings -Threaded fasteners - rolling contact bearings-– Links Design: Path and Motion Synthesis – Cognate Linkages – Design of Spherical Joints.

UNIT III	FUNDAMENTALS OF COMPUTER GRAPHICS	9

Product cycle- Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation.

UNIT IV	CURVES AND MODELLING	9

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Fundamentals of solid modeling, Different solid representation schemes, Half -spaces, Boundary representation (B-rep), Constructive solid geometry (CSG), Sweep representation, Analytic solid modeling.

UNITV	DESIGN OF GRIPPERS	9

Grippers – Types of Grippers Mechanisms – Gripping Methods – Gripping Force analysis – Gripper Design – Two Finger gripper– Magnetic Gripper Design – Vacuum Gripper Design – Hooks – Scoops – Spools – Miscellaneous Grippers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	State the design parameters for designing the components of a robot.
CO2 :	Apply the CAD modelling techniques in designing a Robot
CO3:	Analyse the design parameters for designing the components of a robot.
CO4:	Formulate the methods for designing the entire robot assembly.
CO5:	Create a Robot CAD Model
CO6:	Able to design and analyse the robot gripper.

TEXT BOOKS:	
1.	Joseph Edward Shigley, Charles R. Mischke “Mechanical Engineering Design”, McGraw Hill, International Edition, 1992
2.	Sharma. C.S. and KamleshPurohit, “Design of Machine Elements”, Prentice Hall of India Private Limited, 2003
3.	Ibrahim Zeid, “CAD/CAM theory and Practice”, Tata McGraw Hill, 2nd edition, 2008
4.	Ashby. M.F., “Materials Selection in Mechanical Design”, Third edition, Butterworth-Heineman, New York, 16th edition, 2012
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.
3.	Charles. J. A. and Crane. F. A. A, “Selection and Use of Engineering Materials”, second edition, Butterworth-Heinemann Ltd., 3rd edition 2005.
4.	Kevin Otto, Kristin Wood, “Product Design”, Pearson Education, 7th Reprint, 2011.
5.	Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
6.	Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
7.	Zeid, I., CAD/CAM, McGraw Hil , 2008.

U23RAT42	SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the concepts of measurement technology.
2.	To learn the various sensors used to measure various physical parameters.
3.	To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
4.	To learn about the optical, pressure and temperature sensor
5.	To understand the signal conditioning and DAQ systems

UNIT I	INTRODUCTION	9

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types

UNIT II	MOTION, PROXIMITY AND RANGING SENSORS	9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III	FORCE, MAGNETIC AND HEADING SENSORS	8

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV	OPTICAL, PRESSURE AND TEMPERATURE SENSORS	10

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor.

UNITV	SIGNAL CONDITIONING AND DAQ SYSTEMS	9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Recognize with various calibration techniques and signal types for sensors.
CO2 :	Describe the working principle and characteristics of
CO3:	Apply the various sensors and transducers in various applications.
CO4:	Select the appropriate sensor for different applications..
CO5:	Acquire the signals from different sensors using Data acquisition systems.
CO6:	Acquire the real time applications of Data acquisition systems.

TEXT BOOKS:	
1.	Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2.	Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.
REFERENCE BOOKS:	
1.	C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2.	Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
3.	John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4.	Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5.	Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

U23RAT43	CONTROL SYSTEMS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the components and their representation of control systems
2.	To learn various methods for analyzing the time response, frequency response and stability of the systems
3.	To learn the various approach for the system frequency analysis
4.	To understand the concept of stability analysis
5.	To know about the state variable methods of control system analysis

UNIT I	SYSTEMS COMPONENTS AND THEIR REPRESENTATION	9

Control System: Terminology and Basic Structure-Feed forward and Feedback control theory-Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs

UNIT II	TIME RESPONSE ANALYSIS	9

Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI, PID control systems

UNIT III	FREQUENCY RESPONSE AND SYSTEM ANALYSIS	8

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot-Design of compensators using Bode plots- Cascade lead, lag and lag-lead compensation.

UNIT IV	CONCEPTS OF STABILITY ANALYSIS	10

Concept of stability-Bounded - Input Bounded - Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.

UNIT V	CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS	9

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	State the various control terminologies and concepts.
CO2 :	Know the procedures in developing the transfer function, state space models and time and frequency domain analysis methods.
CO3:	Apply the procedures on developing the systems in transfer function and state space approach and apply to evaluate the performance of system in time and frequency domain techniques.
CO4:	Illustrate the time and frequency response characteristics of system response.
CO5:	Analyze the performance of system using various time and frequency domain

	techniques.
CO6:	Knowledge about control system and its application
TEXT BOOKS:	
1.	Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2.	Sawney A K and PuneetSawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.
REFERENCE BOOKS:	
1.	C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2.	Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
3.	John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
4.	Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
5.	Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

U23RAT44	ROBOT KINEMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce Robots history, terminologies, classification and configurations.
2.	To get knowledge about basic Geometrical and Algebraic approach to solve forward kinematics of serial manipulator.
3.	To get knowledge about advanced forward kinematics of serial manipulator.
4.	To get knowledge about inverse kinematics of various serial manipulator.
5.	To get knowledge about Jacobian aspects and infinitesimal motion of robot mechanisms

UNIT I	OVERVIEW OF ROBOTICS	9

Introduction to Robotics - History - Definitions - Law of Robotics – Terminologies - Classifications Overview – Links & Joints - Degrees of Freedoms - Coordinate Systems - Work Volume - Precision, Repeatability & Accuracy - Position and Orientation of Objects - Roll, Pitch and Yaw Angles - Joint Configuration of Five Types of Serial Manipulators - Wrist Configuration- Overview of end effector.

UNIT II	FORWARD KINEMATICS - GEOMETRICAL AND ALGEBRAIC APPROACH	9

Need for forward and Inverse Kinematics Equation – Parameters in Design and Control – Methods of forward and inverse kinematics- Geometrical and Algebraic Approach in Forward Kinematics Solution, 1 DOF - 2 DOF Planar Robot (2P and 2R); 3DOF 2RP Spatial Robot.

UNIT III	FORWARD KINEMATIC MODELING – DENAVIT-HARTEBERG (DH) APPROACH	9

Unit Circle Trigonometry - Translation Matrix - Rotation matrix - Dot and Cross Products - Frames and Joint Coordinates – Forward kinematics Solution using D-H Convention: 3 DOF wrist , RR Planar, 3 DOF RRP, Cartesian, Cylindrical, Spherical , SCARA and Articulated 3 DOF robots - 3 DOF robot with wrist.

UNIT IV	INVERSE KINEMATICSMODELING	9

Introduction to inverse kinematics -Issues in inverse kinematics - Inverse kinematics of 2 DOF Planar robot - 2 and 3DOF planar and Spatial robot - Tool configuration - Inverse kinematics of 3 axis robot and 6 axis Robot - Inverse kinematics Computation- Closed loop solution.

UNITV	KINEMATIC MODELING OF DIFFERENTIAL DRIVE ROBOT	9

Degree of Mobility - Mobile Robot kinematics - Mobile robot workspace – Representation of robot position – Kinematic models of differential wheel drive - Fixed wheel and steered wheel - Mobile manipulators and its applications - swarm robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Explain the history, classifications, and basic terminologies of robotics and various configuration of robots.
CO2 :	Evaluate forward kinematic model for planar and spatial robot manipulator.

CO3:	Evaluate forward kinematic model for multi-DOF robot manipulators.
CO4:	Evaluate inverse kinematic model for multi-DOF robot manipulators.
CO5:	Evaluate forward kinematic model for differential drive mobile robot.
CO6:	Jacobian aspects and infinitesimal motion of robot mechanisms

TEXT BOOKS:	
1.	Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
2.	John J. Craig, “Introduction to Robotics”, 3rd Edition, Addison Wesley, ISE 2008.
3.	Lynch, Kevin M., and Frank C. Park. Modern Robotics: Mechanics, Planning, and Control 1st ed. Cambridge University Press, 2017.
REFERENCE BOOKS:	
1.	S K Saha, Introduction to Robotics, Tata McGraw-Hill, Second Edition, 2017
2.	Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2017
3.	Arthor Critchlow, “Introduction to Robotics”, 1st edition, Macmillan, 2009.
4.	Mohsen Shahinpoor, “A Robot Engineering Text Book”, 1st edition, Harper and Row, 2004.
5.	Deb S.R., “Robotics Technology and Flexible Automation”, 2nd edition, Tata McGraw - Hill Publis Robotics: Control and Programming.
6.	J. Srinivas, R. V. Dukkipati, K., “Robotics: Control and Programming”, Narosa Publishing House, 2009.
7.	Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, Prentice Hall of India Pvt. Ltd., 2001
8.	Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor - Based integration, Academic Press, 1999.

U23RAT45	ROBOT PATH PLANNING AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Introduce basic trajectory planning problems.
2.	Provide a basic review of various path planning theory of manipulator.
3.	Provide a basic review of various path planning theory of mobile robot.
4.	Introduction to the most widely used classical motion planning algorithms.
5.	Introduce sufficient terminology and concepts in ROS for robot programming.

UNIT I	TRAJECTORY PLANNING APPROACHES	9

Definitions – Task planning and Trajectory planning – Representation of end-effector: Cartesian and joint space schemes. Workspace Analysis: work envelope of a multi DOF manipulator. Applications: Point to point motion and continuous path motion.

UNIT II	TRAJECTORY PLANNING OF MANIPULATOR	9

Joint space techniques – Motion profiles – Cubic polynomial, Linear Segmented Parabolic Blends and cycloidal motion - Cartesian space technique – Straight line and circular trajectories

UNIT III	PATH PLANNING OF MOBILE ROBOT	9

Introduction - Representation of the Robot's Environment - Review of configuration spaces - Visibility Graphs - Voronoi diagrams - Potential Fields – Attractive and Repulsive – Cell Decomposition - Planning with moving obstacles - Probabilistic Roadmaps.

UNIT IV	PATH PLANNING ALGORITHMS	9

Planning - A* Algorithm - the D∗ algorithm - Path control. Graph search and discrete planning algorithms. - Sensor-Based Motion Planning Algorithms – the “Bug” algorithms – the Tangent Bug algorithm.

UNITV	ROS PROGRAMMING	9

Robot language classification - Programming methods: Lead through method, teach pendent method - Syntax features and applications of various programming languages – Examples - Inter locking commands - Safety features - Introduction to Robot Operating System (ROS) - ROS examples - Introduction to programming using ROS - Industrial ROS - ROS examples - Programming for point to point /continuous – operations - Case Study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Recognize various trajectory planning and path planning for mobile robot and Manipulator.
CO2 :	Classify trajectory planning and path planning for mobile robot and Manipulator.
CO3:	Choose appropriate Path and Trajectory planning algorithm for various Industrial Applications.
CO4:	Plan the path and trajectory for various Industrial robots and mobile robots for specific Applications.
CO5:	Program the developed path and trajectory into real time robot applications.

CO6:	Program using the robot operating system.
TEXT BOOKS:	
1.	Niku S B, "Introduction to Robotics, Analysis, Control, Applications", John-Wiley & Sons Inc, 2011.
2.	Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun , "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005
REFERENCE BOOKS:	
1.	Planning Algorithms by Steve LaValle (Cambridge Univ. Press, New York, 2006).
2.	Principles of Robot Motion: Theory, Algorithms, and Implementations (by Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun.
3.	Robot Motion Planning by J.C. Latombe.
4.	Patnaik, Srikanta , "Robot Cognition and Navigation An Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2007.
5.	Reza N Jazar , "Theory of Applied Robotics", Springer, 2010.
6.	Morgan Quigley, Brian Gerkey, William D. Smart, Programming Robots with Ros: A Practical Introduction to the Robot Operating System, First Edition, 2016, ISBN 9352132793; 978- 9352132799

U23GET41	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To the study of nature and the facts about environment.
2.	To finding and implementing scientific, technological, economic and political solutions to environmental problems.
3.	To study the interrelationship between living organism and environment.
4.	To appreciate the importance of environment by assessing its impact on the human world envisions the surrounding environment, its functions and its value.
5.	To study the integrated themes and biodiversity, natural resources, pollution control and waste Management.

UNIT I	**Ecosystem and Biodiversity**	**6**

Definition, Scope and importance of environment – Need for public awareness. Ecosystem Types and Energy flow Ecologicalsuccession.Typesofbiodiversity:genetic,speciesandecosystemdiversity – valuesofbiodiversity,Indiaasamega-diversitynation–hot-spotsofbiodiversity–threatsto biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts endangered and endemic species of India–conservation of biodiversity: In-situ and ex-situ.

UNIT II	Environmental Pollution	6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and SafetyManagementsystem(OHASMS).Environmentalprotection,Environmentalprotectionacts.

UNIT III	Renewable Sources of Energy	**6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal.

UNIT IV	Environmental Issues	**6**

Social Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust - Population growth, variation among nations population explosion – family welfare programme – human rights – value education – HIV / AIDS – women and child welfare.

UNITV	Sustainability Practices	**6**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Development, GDP, Sustainability- Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economic and technological change.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Demonstrate a comprehensive understanding of the world's biodiversity and the importance of its conservation.
CO2 :	Discover knowledge in ecological perspective and value of environment
CO3:	Categorize different types of pollutions and their control measures.
CO4:	Understand the significance of various natural resources and its management.
CO5:	Analyse global environmental problems and come out with best possible solutions.
CO6:	Understand environmental laws and sustainable development.

TEXT BOOKS:	
1.	BennyJoseph,'EnvironmentalScienceandEngineering',TataMcGraw-Hill,NewDelhi,2016.
2.	GilbertM.Masters,'IntroductiontoEnvironmentalEngineeringandScience',2ndedition,Pearson Education,2004.
3.	Allen,D.T.andShonnard,D.R.,SustainabilityEngineering:Concepts,DesignandCaseStudies, PrenticeHall.
4.	J. Manivel and A. Arunkumar, "Environmental Science &Engineering"R.K.Publishers, 1st Edition 2023

REFERENCE BOOKS:	
1.	R.K.Trivedi,'HandbookofEnvironmentalLaws,Rules,Guidelines,CompliancesandStandards', Vol.IandII,EnviroMedia.38.
2.	Cunningham,W.P.Cooper,T.H.Gorhani,'EnvironmentalEncyclopedia',JaicoPubl.,House,Mumbai,2001.
3.	Rajagopalan,R,'EnvironmentalStudies-FromCrisistoCure',OxfordUniversityPress,2005.
4.	ErachBharuch"TextbookofEnvironmentalStudiesforUndergraduateCourses"OrientBlackswanPvt.Ltd.2013.

U23RAP41	SENSORS AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To learn about various force, pressure and vibration measuring sensors.
2.	To learn about various Temperature, light and magnetic field measuring sensors
3.	To learn about various displacement and speed measuring sensors.
4.	To learn about various Direction measurement sensors.
5.	To learn about various pressure and force sensor.

LIST OF EXPERIMENTS

1.	Determination of the characteristics of Pressure Sensor and Piezoelectric Force Sensor
2.	Determination of Displacement using LVDT.
3.	Determine the Characteristics of Various Temperature Sensors.
4.	Determine the Characteristics of Various Light Detectors (Optical Sensors).
5.	Distance Measurement using Ultrasonic and Laser Sensor.
6.	Determine angular velocity of gyroscope,
7.	Vibration measurement using Accelerometer.
8.	Direction measurement using Magnetometer.
9.	Speed, Position and Direction Measurement Using Encoders.
10.	Force Measurement using tactile sensors.
11.	Determination of the characteristics of Pressure Sensor and Piezoelectric Force Sensor

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Load, Torque and Force using Strain Gauge Measurement setup	Each-1
2.	Pressure Sensor and Piezoelectric Force Sensor Measurement setup	Each1
3.	LVDT setup	1
4.	Temperature Sensors measurement setup with RTD, Thermocouple and Thermistor	Each1
5.	Measurement setup Optical Sensors LDR, Phototransistor, photodiode	Each1
6.	Measurement setup-Ultrasonic and Laser Sensor	Each1
7.	Gyroscope measurement setup	1
8.	Accelerometer measurement setup	1
9.	Magneto meter measurement setup	1
10.	Absolute Encoders and Incremental encoder with DSO/single board computer	Each1
11.	DAQ with sensor or transducer	1
12.	3axisforcesensorwithmeasurementsetup	1
13.	Tactile Sensor with touch measurement setup	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Demonstrate the various contact and non-contact sensors..
CO2 :	Analyze and Identify appropriate sensors for given applications.

CO3:	Create a sensor system for given requirements.
CO4:	Identify the need of sensors for various application
CO5:	DAQ with various sensors
CO6:	Create the basic sensor arrangement for an automation system

U23RAP42	ROBOT MODELLING AND SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Make the students knowledgeable in modeling the basic components of a robot
2.	Make the students knowledgeable in modeling some common joints, links and transmission assembly for a robot.
3.	Make the students knowledgeable in modeling a robot and its end effector.
4.	Make the students knowledgeable in mobile robots.
5.	Make the students to get the basic knowledge in harmonic gear drive.

LIST OF EXPERIMENTS

1.	2D Sketch of a Gear.
2.	2D Sketch and 3D modelling of Sheet Metal Components
3.	3D Modelling Mounting clamp for motor.
4.	3D Modelling of GT2 pulley and belt drive system
5.	3D Modelling Ball Screw and Nut assembly.
6.	3D Modelling and motion simulation of Rotational Joint assembly.
7.	3D Modelling and motion simulation of Prismatic Joint assembly.
8.	3D modelling and simulation of Cartesian Robot
9.	3D modelling of 4 Wheeled 2 steering Mobile Robot.
10.	Study on Harmonic Gear drive.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Computers	15
2.	CAD modelling packages –open source/licensed	15

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Identify components and physical features of various parts for a robot system and sub systems
CO2 :	Model components and physical features of various parts for a robot system and sub systems
CO3:	Create a CAD and simulation model for a robot system and sub systems.
CO4:	Create a CAD and simulation model for a Cartesian robot.
CO5:	Create a CAD and simulation model for wheeled robot system.
CO6:	Acquired basic knowledge in harmonic gear drive.

U23RAP43	CONTROL SYSTEMS ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To make the students familiarize various representations of systems.
2.	To make the students analyze the stability of linear systems in time domain and frequency domain.
3.	To make the students design compensator based on the time and frequency domain Specifications.
4.	To develop linear models mainly state variable model and Transfer function model
5.	To make the students to design a complete closed loop control system for the physical systems

LIST OF EXPERIMENTS

1.	Mathematical Modelling and Simulation of a Physical Systems and
2.	Simulation and Reduction of Cascade and Parallel, and Closed Loop Sub-System.
3.	Simulation and Analysis of First and Second Order System Equations in Time and Frequency Domain.
4.	Simulation and Analysis of System using Root-Locus and Bode Plot.
5.	Simulation and Implementation of PID Combination for First Order Systems.
6.	Simulation and Implementation of PID Combination Second Order Systems.
7.	Determination of transfer function parameters of armature controlled DC servo Motor
8.	Determination of transfer function parameters of field controlled DC servo Motor
9.	Determination of transfer function parameters of an AC servo Motor
10.	Study of Synchros.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S. no	Name of the Equipment	Quantity
1.	PID Controller simulation and learner kit	1
2.	Digital Storage oscilloscope for capturing transience	1
3.	Control system simulation packages (Open source / licensed version)	10
4.	Dc motor – generator test setup	1
5.	CRO 30MHz	1
6.	Position Control Systems Kit (with manual)	1
7.	Tacho Generator Coupling set	1
8.	AC Synchro transmitter& receiver	1
9.	Digital multi meters, speed and torque sensors	Each 5

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Design and implement simple controllers in standard forms.
CO2 :	model and analyze simple physical systems and simulate the performance in analog and digital platform
CO3:	To design a complete closed control loop and evaluate its performance for simple physical systems
CO4:	design compensators based on time and frequency domain specifications

CO5:	Analyze the stability of a physical system in both continuous and discrete domain
CO6:	Develop the loop system based on real time application

U23RAT51	EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To familiarize the architecture and fundamental units of microcontroller.
2.	To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3.	To design the interface circuit and programming of I/O devices, sensors and actuators.
4.	To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5.	To acquaint the knowledge of real time embedded operating system for advanced system developments.

UNIT I	INTRODUCTION TO MICROCONTROLLER	9

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

UNIT II	PROGRAMMING AND COMMUNICATION	9

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE- C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT III	PERIPHERAL INTERFACING	9

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

UNIT IV	ARM PROCESSOR	9

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

UNIT V	SINGLE BOARD COMPUTERS AND PROGRAMMING	9

System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages– Python for Embedded Systems- GPIO Programming – Interfacing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.
CO2 :	Recognize the role of each functional units in microcontroller, processors and system- on- chip based on the features and specifications.

CO3:	Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing..
CO4:	Design the circuit and write the programming microcontroller, processors and system on chip.
CO5:	Develop the applications using Embedded system.
CO6:	Acquire knowledge in real time programing and Interfacing.

TEXT BOOKS:	
1.	Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2.	Kenneth J. Aylala, "The 8051 Microcontroller,

REFERENCE BOOKS:	
1.	Muhammad Ali Mazidi and Janice Gillispic Mazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2.	Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015
3.	James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4.	John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005

U23RAT52	FLUID POWER SYSTEMS AND INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
2.	To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
3.	To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
4.	To learn about the fundamentals of Programmable Logic Controller.
5.	To familiarize the Data Communication and Supervisory Control Systems.

UNIT I	FLUID POWER SYSTEM GENERATION AND ACTUATORS	9

Need For Automation, Classification of Drives - Hydraulic, Pneumatic and Electric –Comparison – ISO Symbols for their Elements, Selection Criteria. Generating Elements- Hydraulic Pumps and Motor Gears, Vane, Piston Pumps – Motors - Selection and Specification - Drive Characteristics – Utilizing Elements - Linear Actuator – Types, Cushioning – Accumulators.

UNIT II	CONTROL AND REGULATIING ELEMENTS	9

Control and Regulating Elements — Direction, Flow and Pressure Control Valves -Methods of Actuation, Types, Sizing of Ports. Spool Valves - Operating Characteristics

UNIT III	CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS	9

Typical Design Methods - Sequencing Circuits Design - Combinational Logic Circuit Design - Cascade Method - KV Mapping - Electrical Control of Pneumatic and Hydraulic Circuits - Use of Relays, Timers, Counters and PLC in pneumatics and hydraulics

UNIT IV	PROGRAMMABLE LOGIC CONTROLLER	9

Industrial Automation - Programmable Logic Controller - Functions of PLCs - Features of PLC - Selection of PLC - Architecture - IEC61131-3 programming standard and types - Basics of PLC Programming - Ladder Logic Diagrams - Communication in PLC - Programming Timers and Counters - Data Handling - PLC modules - Advanced motion controlled Multi Axis PLC

UNITV	DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS	9

Industrial Data Communications - Modbus – HART – Device Net – Profibus – Fieldbus – RS232-RS485- Modbus/ Modbus TCP/IP– CAN – EtherCAT - Introduction to Supervisory - Control Systems – SCADA - Distributed Control System (DCS) – Safety Systems – human machine interfaces - Total Integrated Automation (TIA) – Industry 4.0.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Recognize the various concepts of fluid power and PLC systems.

CO2 :	Comprehend functions of fluid power and PLC systems.
CO3:	Explain the various standard fluid power circuits, functions, communication and IO details of PLC
CO4:	Demonstrate the standard fluid power circuits and PLC based interfaces.
CO5:	Construct the fluid power circuits and PLC based automation system.
CO6:	Demonstrate the Data Communication And Supervisory Control System

TEXT BOOKS:	
1.	Antony Esposito, "Fluid Power Systems and Control", Prentice-Hall, 2006.
2.	Peter Rohner, "Fluid Power Logic Circuit Design", the Macmillan Press Ltd., London, 1979.
3.	Frank D, Petruzella, "Programmable Logic Controller" McGraw – Hill Publications, Fourth Edition, 2016

REFERENCE BOOKS:	
1.	Lucas, M.P., "Distributed Control System", Van Nastrand Reinhold Company, New York, 1986.
2.	Mackay S., Wrijut E., Reynders D. and Park J., "Practical Industrial Data Networks Design, Installation and Troubleshooting", Newnes Publication, Elsevier, First Edition, 2004.
3.	Patranabis. D, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Ltd., New Delhi, 1999.

U23RAP51	FLUID POWER SYSTEMS INDUSTRIAL AUTOMATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits.
2.	To practice the fundamentals of Programmable Logic Controller.
3.	To practice the Data Communication between PLC
4.	To create a ladder program for industrial automation application.
5.	To acquire a knowledge in PLC in basic interfacing.

LIST OF EXPERIMENTS

	FLUID POWER DRIVES
1.	Experimental Verification of Speed Control Circuits in Pneumatic and Hydraulic Trainer.
2.	Experimental Verification of Single and Double Acting Cylinder Circuits Using Different Directional Control Values.
3.	Experimental Verification of Electro-Pneumatic Circuits.
4.	Experimental Verification of Pneumatic Sequencing Circuits.
5.	Experimental Verification of Logic, Metre-in and Metre-out Pneumatic Circuits.
	INDUSTRIAL AUTOMATION
6.	Design a Ladder Logic Program for various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR.
7.	Develop Ladder Diagram Programming to set Timer and Counter in PLC.
8.	Develop PLC Program to Control Traffic Light.
9.	Develop PLC Program to Maintain the Pressure and Level in a Bottle Filling System.
10.	Develop Ladder Diagram Program in PLC for Material Filling, Object Sorting.
11.	Develop the Ladder Diagram Program in PLC for Material Handling, Delaying Conveyor, Pick and Place Operation.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
	Hydraulic Equipment	
1.	Pressure relief valve	4
2.	Pressure reducing valves	2
3.	Flow control valves	2
4.	Pressure switch	1
5.	Limits witches	2
6.	Linear actuator	1
7.	Rotary actuator	1
8.	Double solenoid actuated DCV	1
9.	Single solenoid actuated DCV	1

10.	Hydraulic power pack with pump and pressure relief valve	1
11.	PLC with hydraulic interface	1set
	Pneumatics Equipment	
1.	Pneumatic trainer kit with FRL Unit, Single acting cylinder, pushbutton	1
2.	Pneumatic training kit with FRL unit, Double acting cylinder, manually actuated DCV	1
3.	Pneumatic trainer kit with FRL unit, Double acting cylinder, Pilot actuated DCV	1
4.	Pneumatic trainer kit with FRL unit Double acting cylinder,Double solenoid actuated DCV,DCV with sensor/magnetic reed switches	1
5.	PLC with Pneumatic Interface.	1
	Industrial Automation Equipment	
1.	PLC Programming software (opensource/licensed)	15
1.	PLC to PLC communication station IO switch sensors and actuators.	1set
2.	• Bottle Filling System. • Material Filling • Object Sorting • Orientation Check • Material Property Check. • Material Handling, Delaying Conveyor, Feeding, Pick and Place Operation	Each1No.

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Design and simulate the fluid power circuits
CO2 :	Test the simulated output by constructing the fluid power circuits using suitable actuators and valves.
CO3:	Practice the PLC programming, Interfacing with IO and establish the communication between stations
CO4:	Practice the PLC ladder program for industrial automation application.
CO5:	Various types of PLC and its programming techniques.
CO6:	Data transfer between PLC stations.

U23RAP52	EMBEDDED SYSTEMS AND PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To program the 8051 microcontroller using assembly language.
2.	To program the ARM processor in computation platform
3.	To interface the real time products with 8051 controller and ARM processor.
4.	To program in real time embedded programming softwares.
5.	To know the applications of IOT

LIST OF EXPERIMENTS

1.	Assembly Language Programming and Simulation of 8051.
2.	Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3.	Input switches and keyboard interfacing of 8051.
4.	Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051. .
5.	Timer, Counter and Interrupt Program Application for 8051.
6.	Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with 8051.
7.	UART Serial and Parallel Port Programming of 8051.
8.	I2C, SPI and CAN Programming of 8051.
9.	Interfacing and Programming of Bluetooth and Wi-Fi with 8051
10.	Programming of ARM Processor for Sensor Interface.
11.	Stepper Motor and Servo Motor Control Using ARM Processor.
12.	Serial Communication of ARM Processor with Computation Platform.
13.	Wireless Communication of ARM Processor with Computation Platform.
14.	GPIO Programming of Real Time Embedded Operating Systems.
15.	IOT application using SBC

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Computers	15
2.	8051trainerkitinterfacedwithabovecomputers	2
3.	AlphanumericandGraphicLCDInterfacinginterfacedwith8051	1Each
4.	Switchesandkeyboardinterfacingof8051.	1Each
5.	SensorInterfacingwithADCto8051andDAC&RTCInterfacingwith 8051kit	1Each
6.	UARTSerialandParallelPortwith8051kit	1Each
7.	I^2C,SPIandCANprotocolswith8051kit	1Each
8.	StepMotor(Unipolar&BipolarMotor)andPWMServoMotorControltoInterfacingwith8051kit	1each
9.	InterfacingandProgrammingofBluetoothandWi-Fiwith8051kit	1each

10.	ARM Processor–kit/development boards-2nos With WIFI module, Sensors, Stepper motor and servomotor –1each	1Set
11.	Single board computer (Raspberry PI/ any other open source boards)with internet provision and open source IOT service provider setup	1set
12.	Softwarefor8051programming	15No's

COURSE OUTCOMES:

At the end of the course the students would be able to:

CO1 :	Analysis the usage of various on chip resources like Timers, Interrupts ADC, DAC, comparator and RTC.
CO2 :	Design Embedded systems to suit market requirement
CO3:	Solve engineering problems by proposing potential solutions using industry choice advanced micro controllers.
CO4:	Provide embedded system solutions for societal needs.
CO5:	Work individually and in a group to develop embedded system.
CO6:	Communicate effectively in oral and return forming a field of embedded system.

U23GE3361	PROFESSIONAL DEVELOPMENT	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Gain proficiency in using MS WORD to create high-quality technical documents, effectively utilizing standard templates, widely accepted styles, and formats to enhance the content's presentability and overall utility value.
2.	To be proficient Master data manipulation tasks in MS EXCEL, including common statistical, logical, and mathematical operations, as well as conversion, analytics, search, exploration, visualization, and the use of critical features.
3.	To Acquire essential skills in creating top-notch presentations with MS PowerPoint, focusing on content organization, presentability, aesthetics, and the seamless integration of media elements to enhance the overall quality of the presentations.
4.	Develop a thorough understanding of MS WORD's various features, such as document formatting, headers, footers, table creation, and effective use of graphics to enhance the visual appeal and readability of technical documents.
5.	Explore advanced functionalities of MS EXCEL, including data analysis tools, pivot tables, macros, and data visualization techniques, to efficiently handle complex datasets and perform insightful data analysis.

MS WORD: **10**

- ✓ Create and format a document
- ✓ Working with tables
- ✓ Working with Bullets and Lists
- ✓ Working with styles, shapes, smart art, charts
- ✓ Inserting objects, charts and importing objects from other office tools.
- ✓ Creating and Using document templates
- ✓ Inserting equations, symbols and special characters
- ✓ Working with Table of contents and References, citations
- ✓ Insert and review comments
- ✓ Create bookmarks, hyperlinks, endnotes footnote
- ✓ Viewing document in different modes
- ✓ Working with document protection and security.
- ✓ Inspect document for accessibility

MS EXCEL: **10**

- ✓ Create worksheets, insert and format data
- ✓ Work with different types of data: text, currency, date, numeric etc.
- ✓ Split, validate, consolidate, Convert data
- ✓ Sort and filter data
- ✓ Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
- ✓ Work with Lookup and reference formulae
- ✓ Create and Work with different types of charts
- ✓ Use pivot tables to summarize and analyse data
- ✓ Perform data analysis using own formulae and functions

- ✓ Combine data from multiple worksheets using own formulae and built-in functions to generate results
- ✓ Export data and sheets to other file formats
- ✓ Working with macros
- ✓ Protecting data and Securing the workbook

MS POWERPOINT:	**10**

- ✓ Select slide templates, layout and themes
- ✓ Formatting slide content and using bullets and numbering
- ✓ Insert and format images, smart art, tables, charts
- ✓ Using Slide master, notes and handout master
- ✓ Working with animation and transitions
- ✓ Organize and Group slides
- ✓ Import or create and use media objects: audio, video, animation
- ✓ Perform slideshow recording and Record narration and create presentable videos

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Utilize Microsoft Word to create and format professional documents, such as reports, memos, and letters.
CO2 :	Create and manage spreadsheets using Microsoft Excel, including data entry, formula usage, and data analysis.
CO3:	Design visually appealing presentations using Microsoft PowerPoint, incorporating multimedia elements and effective slide layouts.
CO4:	Effectively communicate and collaborate with others using Microsoft Outlook for email management.
CO5:	Develop and maintain organized databases using Microsoft Access, including data entry, query design, and report generation.
CO6:	Create scheduling and task tracking in the working environment

U23RAT61	ROBOT DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To learn and understand generalized co-ordinates, Jacobian matrix Mass Distribution and other fundamental equations.
2.	To understand Lagrangean and Hamiltonian mechanics
3.	To understand nonlinearities in control system
4.	To Understand various force control strategies
5.	To understand various concepts in linearizing a no linear signal.

UNIT I	ROBOT FORCE MODELS	9

Generalized co-ordinates - Generalized Forces - Equation of Motions – Static Forces in Manipulators - Jacobian matrix - Jacobians in The Force Domain - Cartesian Transformation of Velocities and Static Forces - Acceleration of A Rigid Body – Nonrigid Body.

UNIT II	ROBOT DYNAMICS	9

General Expressions for Kinetic and Potential Energy - Kinetic Energy for an n-Link Robot - Potential Energy for an n-Link Robot - Equations of Motion -Lagrangian Multiplier - Langrage's Equation.

UNIT III	ROBOT CONTROL SYSTEM	9

Functions of controller and power amplifier. Joint actuators- stepper motor, servo motor. Control Schemes: PID control scheme – Position and force control schemes. Robotic sensors and its classification, Internal sensors – Position, velocity, acceleration and force information, External Sensors – Contact sensors-Limit switches, piezoelectric, pressure pads, Non-contact sensors – Range sensors, Vision sensor- robotic vision system.

UNIT IV	CONTROL OF MANIPULATORS	9

Linear Time Varying and Linearization – Input and Output Stability - Background: The Frobenius Theorem - Single-Input Systems. Introduction to nonlinear system – time varying systems - multi-input, multi-output control systems - practical considerations - current industrial - robot control systems

UNITV	FORCE CONTROL	9

Constrained Dynamics - Static Force/Torque Relationships - Constraint Surfaces - Natural and Artificial Constraints - Network Models and Impedance - Impedance Operators - Classification of Impedance Operators.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Describe generalized co-ordinates, Jacobian matrix Mass Distribution and equation of motion.
CO2 :	Develop the static force model and inverse dynamic model of multi-degree of freedom (DOF) manipulator. Evaluate dynamics of robot using Lagrangian and

	Hamiltonian mechanics.
CO3:	Describe the control architecture of robot manipulator
CO4:	Evaluate linear and nonlinearities in dynamics of robot.
CO5:	Develop the control strategies for robot system.
CO6:	Evaluate the dynamics of the robots ytems.

TEXT BOOKS:	
1.	Mark W. Spong, Seth Hutchinson, M. Vidyasagar.
2.	John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005.

REFERENCE BOOKS:	
1.	Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int., 1986.
2.	K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
3.	Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & sons, Inc., 2011
4.	Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.

U23RAT62	MACHINE LEARNING FOR INTELLIGENT SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce basic machine learning techniques such as regression, classification
2.	To learn about introduction of clustering, types and segmentation methods
3.	To learn about fuzzy logic, fuzzification and defuzzification
4.	To learn about basics of neural networks and neuro fuzzy networks.
5.	To learn about Recurrent neural networks and Reinforcement learning.

UNIT I	INTRODUCTION TO MACHINE LEARNING	9

Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

UNIT II	CLUSTERING AND SEGMENTATION METHODS	9

Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbour algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

UNIT III	FUZZY LOGIC	9

Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application

UNIT IV	NEURAL NETWORKS	9

Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics

UNITV	RNN AND REINFORCEMENT LEARNING	9

Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand basic machine learning techniques such as regression, classification.
CO2 :	Understand about clustering and segmentation
CO3:	Model a fuzzy logic system with fuzzification and defuzzification
CO4:	Understand the concepts of neural networks and neuro fuzzy networks.
CO5:	Gain knowledge on Reinforcement learning.

CO6:	Applying neural network in prediction of industrial process.
TEXT BOOKS:	
1.	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011
REFERENCE BOOKS:	
1.	Bruno Siciliano, OussamaKhatib, “Handbook of Robotics”, 2016 2nd Edition, Springer
2.	Simon Haykin, “Neural Networks and Learning Machines: A Comprehensive Foundation”, Third Edition, Pearson, delhi 2016.
3.	Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4th Edition, Chichester, 2011, Sussex Wiley

U23RAP61	ROBOT KINEMATICS AND DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To model and simulate a robot and verify its kinematics
2.	To model and simulate a robot and generate a trajectory plan.
3.	To model and simulate a robot and verify its dynamics
4.	To model and simulate a various DOF of robot by varying trajectories
5.	To model and simulate a robot Forward and Inverse Dynamics.

LIST OF EXPERIMENTS

1.	Verification of Forward Kinematics for 2R, 2P and RP Robot.
2.	Verification of D-H transformation for 6DOF Serial manipulator
3.	Verification of Inverse Kinematics for 2R, 2P and RP Robot.
4.	Verification of Forward Kinematics for 3R spatial Robot
5.	Verification of Inverse Kinematics for 3R spatial Robot.
6.	Kinematic Analysis of 2R planar robot for varying trajectories using Roboanalyzer
7.	Workspace Analysis of 2R planar robot manipulator for a specified trajectory
8.	Kinematic Analysis of 6 DOF robot for varying trajectories using Roboanalyzer
9.	Inverse Dynamic Analysis of 6 DOF robot for varying trajectories using Roboanalyzer
10.	Forward and Inverse Dynamics of 2R planar robot using Roboanalyzer

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	PC workstation	15
2.	Robot Analyse r(opensource) installed on computer	15
3.	ROS with Gazebo/moveit/v-rep installed on computer	15
4.	Robot	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Analyze the kinematics and dynamics for various robots
CO2 :	Simulate and evaluate the kinematics and dynamics for various robots
CO3:	Create a robot and program a trajectory plan for the robot
CO4:	Analyze the kinematics and dynamics for various DOF robot by varying trajectories
CO5:	Simulate and evaluate the kinematics and dynamics for planar robots
CO6:	Acquired knowledge about programming using robot operating system.

U23RAP62	INOVATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To enable the students with new ideas, executing them, and iterating until the idea is fully executed or integrated.
2.	Students have to do a Mechatronics project based on their idea. It can be a modelling, simulation, design or hardware project

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Develop the ideas into simulation or working models
CO2 :	Identifying the tools to implement the ideas to create a new model
CO3:	Modelling and simulation of mechatronics model
CO4:	Converting new idea into a prototype
CO5:	Trouble shoot the real time working models
CO6:	Get a vision to convert an idea / prototype into a new working model

U23HSP61	PROFESSIONAL COMMUNICATION	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Making effective presentations.
2.	Attending job interviews and be successful in them.
3.	Developing adequate Soft Skills required for the workplace.
4.	Nurturing out ward look.
5.	Impressing the listener by positive body language.

LIST OF EXPERIMENTS

1.	Introduction to Soft Skills.
2.	Employability and career Skills.
3.	Grooming as a professional with values.
4.	Time Management.
5.	General awareness of Current Affairs.
6.	Self-Introduction.
7.	Introducing oneself to the audience .
8.	Introducing the topic.
9.	Individual presentation practice.
10.	Participating in group discussions.
11.	GD strategies- activities to improve GD skills.
12.	Interview etiquette.
13.	Telephone/skype interview -one to one interview &panel interview.
14.	The International English Language Testing System (IELTS).
15	Test of English as a foreign Language (TOFEL)-Verbal Ability.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Organize an effective group discussions.
CO2 :	Develop confidence to attend job interviews.
CO3:	Explain their opinion effectively in oral medium of communication
CO4:	Prove as technical managers and problem solvers.
CO5:	Motivate themselves to move smartly in professional society.
CO6:	Build hope to prove their entrepreneurial ship.

U20RAT71	ROBOT VISION SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the basics concepts of optics and vision systems.
2.	To learn and understand the fundamentals of image processing
3.	To impart knowledge on object recognition and feature extraction.
4.	To understand algorithms in image processing.
5.	To demonstrate the various applications of machine vision system

UNIT I	IMAGE ACQUISITION	9

The Nature of Vision- Robot vision – Need, Applications - image acquisition – Physics of Light – Interactions of light – Refraction at a spherical surface – Illumination techniques - linear scan sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation .

UNIT II	IMAGE PROCESSING FUNDAMENTALS	9

Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Image Smoothing–Image segmentation– Object Recognition and Image Understanding. Feature extraction: Region Features, Gray Value Features, Contour Features– Morphology– Edge extraction– Fitting and Template matching.

UNIT III	OBJECT RECOGNITION AND FEATURE EXTRACTION	9

Image segmentation- Edge Linking-Boundary detection-Region growing-Region splitting and merging- Boundary Descriptors-Freeman chain code-Regional Descriptors- recognition- structural methods- Recognition procedure

UNIT IV	COLLISON FRONTS ALGORITHM	9

Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects..

UNITV	ROBOT VISION APPLICATION	9

Case study-Automated Navigation guidance by vision system – vision based de palletizing- line tracking-. Automatic part Recognition. Image processing techniques implementation through Image Processing software

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Know the various types of sensors, lightings, hardware and concept of machine vision.
CO2 :	Acquire the image by the appropriate use of sensors, lightings and hardware.
CO3:	Apply the various techniques of image processing in real time applications.
CO4:	Select the suitable sensors, lightings and hardware.
CO5:	Apply the vision techniques in Robot vision system.
CO6:	Apply the image based object recognition.

TEXT BOOKS:	
1.	Rafael C. Gonzales, Richard. E. Woods, "Digital Image Processing Publishers", Fourth Edition
2.	Emanuele Trucco, Alessandro Verri, "Introductory Techniques For 3D Computer Vision", First Edition
REFERENCE BOOKS:	
1.	Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, "An Invitation to 3-D Vision From Images to Models", First Edition, 2004
2.	Fu .K.S, Gonzalez .R.S, Lee .C.S.G, "Robotics – Control Sensing, Vision and Intelligence", Tata McGraw-Hill Education, 2008.
3.	RafelC.Gonzalez, Richard E.Woods,StevenL.Eddins, "Digital Image Processing using MATLAB", 2nd edition, Tata McGraw Hill, 2010.

U23RAT72	MOBILE ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce mobile robotic technology and its types in detail.
2.	To learn the kinematics of wheeled and legged robot.
3.	To familiarize the intelligence into the mobile robots using various sensors.
4.	To acquaint the localization strategies and mapping technique for mobile robot.
5.	To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT I	INTRODUCTION TO MOBILE ROBOTICS	6

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles – Teleportation and Control.

UNIT II	KINEMATICS	9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints– Degree of Mobility and Steerability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots – Open Loop and Feedback Motion Control ..

UNIT III	PERCEPTION	9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Active Ranging - Motion/Speed Sensors – Vision Based Sensors – Uncertainty - Statistical Representation - Error Propagation - Feature Extraction Based on Range Data (Laser, Ultrasonic, Vision-Based Ranging) - Visual Appearance based Feature Extraction.

UNIT IV	LOCALIZATION	12

The Challenge of Localization - Sensor Noise and Aliasing - Effector Noise – Localization Based Navigation Versus Programmed Solutions - Belief Representation –Map Representation - Continuous Representations - Decomposition Strategies - Current Challenges In Map Representation - Probabilistic Map-Based Localization - Markov Localization - Kalman Filter Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building- Stochastic Map Technique - Other Mapping Techniques.

UNITV	PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS	9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Modularity for Code Reuse and Sharing - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Evaluate the appropriate mobile robots for the desired application.
CO2 :	Analyze the sensors for the intelligence of mobile robotics

CO3:	Evaluate the kinematics for given wheeled and legged robot.
CO4:	Create the localization strategies and mapping technique for mobile robot..
CO5:	Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.
CO6:	Create a navigation technology along the robot application.

TEXT BOOKS:	
1.	Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.
REFERENCE BOOKS:	
1.	Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2.	MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
3.	Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4.	Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5.	Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
6.	Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159

U23GET61	HUMAN VALUES AND ETHICS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Teach definition and classification of values.
2.	Explain Purusartha.
3.	Describe Sarvodaya idea.
4.	Summarize sustenance of life.
5.	Conclude views of hierarchy of values.

UNIT I	DEFINITION AND CLASSIFICATION OF VALUES	9

Extrinsic values- Universal and Situational values- Physical- Environmental-Sensuous- Economic Social-Aesthetic-Moral and Religious values.

UNIT II	CONCEPTS RELATED TO VALUES	9

Purusartha-Virtue- Right- duty- justice- Equality- Love and Good.

UNIT III	IDEOLOGY OF SARVODAYA	9

Egoism- Altruism and universalism- The Ideal of Sarvodaya and VasudhaivaKutumbakam.

UNIT IV	SUSTENANCE OF LIFE	9

The Problem of Sustenance of value in the process of Social, Political and Technological Changes.

UNITV	VIEWS ON HIERARCHY OF VALUES	9

The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand definition and classification of values.
CO2 :	Understand purusartha.
CO3:	Understand sarvodaya idea.
CO4:	Understand sustenance of life.
CO5:	Understand the hierarchy of values.
CO6:	Compare hierarchial views of Pt. Madan Mohan Malviya and Mahatma Gandhi.

TEXT BOOKS:

1.	Awadesh Pradhan :MahamanakeVichara. (B.H.U., Vanarasi-2007)
2.	Little, William, : An Introduction of Ethics (Allied Publisher, Indian Reprint 1955)
3.	William, K Frankena : Ethics (Prentice Hall of India, 1988)

U23RAP71	ROBOTICS AND INTELLIGENCE LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand various lighting techniques, design and image acquisition of machine vision system.
2.	To practice Feature Extraction, Image pre-processing and pattern recognition.
3.	To apply machine learning technique to classification and object detection.
4.	To apply the above mentioned techniques with the help of a Robot.
5.	To understand the appropriate selection and usage of vision sensors.

LIST OF EXPERIMENTS

1.	Study on different kinds of vision sensors and lighting techniques for machine vision
2.	Study on Design of Machine Vision System.
3.	Experimentation on image acquisition towards the computation platform.
4.	Pre-processing techniques in image processing
5.	Edge detection and region of interest extraction.
6.	Experimentation with image processing algorithm for feature extraction.
7.	Vision based image classification using Machine Learning Techniques.
8.	Vision based Object detection using Machine Learning Techniques.
9.	Robot assisted image acquisition.
10.	Vision based defect identification

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	PC workstation	15
2.	Robot with Data Acquisition system (image sensor incorporated)	2
3.	Machine Learning Software.	15

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Selection of the appropriate lighting techniques for a specific application.
CO2 :	Analyse the image pre-processing, extraction and pattern recognition.
CO3:	Analyse the process with the help of machine learning techniques.
CO4:	Incorporate the image processing techniques with a Robot.
CO5:	Select the appropriate vision sensors for an specific application.
CO6:	Formulate a machine vision system for a specific application with the help of a Robot.

U23RAP72	PROJECT WORK - I	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
2.	To train the students in preparing project reports and to face reviews and viva voce examination.
3.	The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor.
4.	The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester.
5.	The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.
CO2 :	Develop project management skills for effective planning and execution.
CO3:	Collaborate in cross-functional teams to achieve project objectives.
CO4:	Apply critical thinking and problem-solving techniques to address project challenges.
CO5:	Foster creativity and innovation in project solutions and deliverables.
CO6:	Communicate project progress and outcomes through effective presentations and reports.

U23RAP81	PROJECT WORK - II	L	T	P	C
		0	0	20	10

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
2.	To train the students in preparing project reports and to face reviews and viva voce examination.
3.	The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor.
4.	The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester.
5.	The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 180 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.
CO2 :	Develop project management skills for effective planning and execution.
CO3:	Collaborate in cross-functional teams to achieve project objectives.
CO4:	Apply critical thinking and problem-solving techniques to address project challenges.
CO5:	Foster creativity and innovation in project solutions and deliverables.
CO6:	Communicate project progress and outcomes through effective presentations and reports.

VERTICALS – I (APPLIED ROBOTICS)

U23RAV11	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To get a knowledge of working on Industrial robots and their load handling capacity
2.	To enlist with an application of robots in various operation
3.	To familiar with a material handling system
4.	To impart the knowledge on robotic welding
5.	To obtain the knowledge on various type of robot welding operation

UNIT I	INTRODUCTION	9

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centred cell

UNIT II	SELECTION OF ROBOTS AND OTHER APPLICATIONS	9

Factors influencing the choice of a robot - robot performance testing - economics of robotisation - Impact of robot on industry and society. Application of Robots in continuous arc welding - Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.

UNIT III	MATERIAL HANDLING	9

Concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems (ASRS) - bar code technology - radio frequency identification technology.

UNIT IV	ROBOTIC WELDING	9

Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding.

UNITV	APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES	9

Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize various concepts of Industrial Robot.
CO2 :	Select the appropriate manufacturing procedure for Robots

CO3:	Apply various manufacturing process in Robot manufacturing.
CO4:	Learn about the Welding operation and also related to Programming
CO5:	Produce a manufacturing plan for developing a robot
CO6:	Apply Robot application in welding process in hazardous environment.

TEXT BOOKS:

1.	Richard D Klafter, Thomas Achmielewski, MickaelNegin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2006.
2.	Mikell P Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2019.
3.	Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.

REFERENCE BOOKS:

1.	Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013.
2.	John A. piotrowski, William T. Randolph , "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.
3.	Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, AshishDutta , "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2012.
4.	YoramKoren , "Robotics for Engineers", McGraw-Hill, 1987.

U23RAV12	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the basics of drone concepts
2.	To learn and understand the fundaments of design, fabrication and programming of drone
3.	To impart the knowledge of and flying and operation of drone
4.	To know about the various applications of drone
5.	To understand the safety risks and guidelines of fly safely.

UNIT I	INTRODUCTION TO DRONE TECHNOLOGY	9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT II	DRONE DESIGN, FABRICATION AND PROGRAMMING	9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT III	DRONE FLYING AND OPERATION	9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications.

UNIT IV	DRONE COMMERCIAL APPLICATIONS	9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

UNITV	FUTURE DRONES AND SAFETY	9

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z – transforms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Know about a various type of drone technology, drone fabrication and programming.
CO2 :	Execute the suitable operating procedures for functioning a drone.
CO3:	Select appropriate sensors and actuators for Drones
CO4:	Develop a drone mechanism for specific applications
CO5:	Create the programs for various drones.

CO6:	Develop a drone mechanisms ideology for a specific and new application
TEXT BOOKS:	
1.	Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2.	Terry Kilby and Belinda Kilby, "Make:Getting Started with Drones ",Maker Media, Inc, 2016.
REFERENCE BOOKS:	
1.	John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2.	Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

U23RAV13	MICRO ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To expose students to the fundamental aspects of the emerging field of micro robotics.
2.	To expose students to micro scale, technologies for fabricating small devices, bio-inspired design, and applications of the field.
3.	To expose students to various Mathematical formalism for flexures, Electrostatic actuators, Piezo-electric actuators, Magneto-strictive actuator and other sensors.
4.	To apply micro robotics to various applications
5.	To engage students in implementation of micro robotics.

UNIT I	INTRODUCTION TO MICROROBOTICS	9

Introduction to Micro robotics -MST (Micro System Technology) - Micromachining - Working principles of Microsystems Applications of Microsystems - Micro-fabrication principles-Design selection criteria for micromachining - Packaging and Integration aspects - Micro-assembly platforms and manipulators.

UNIT II	SCALING LAWS AND MATERIALS FOR MEMS	9

Introduction - Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties - compatible material system - Shape memory alloys - Material properties - Piezoresistivity, Piezoelectricity and Thermoelectricity.

UNIT III	FLEXURES, ACTUATORS AND SENSORS	9

Elemental flexures - Flexure systems - Mathematical formalism for flexures - Electrostatic actuators - Piezo-electric actuators – Electromagnetic sensors - Optical-based displacement sensors - Motion tracking with microscopes.

UNIT IV	MICROROBOTICS	9

Introduction - Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro- robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots.

UNITV	IMPLEMENTATION OF MICROROBOTS	9

Arrayed actuator principles for micro-robotic applications - Micro grippers and other micro-tools - Micro-conveyors - Micro-robotic actuators - Micro-robotics devices - Multi-robot system: Micro-robot powering, Micro-robot communication.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Explain and apply the concepts of mass, energy, and momentum balance in micro robotics.
CO2 :	Apply adapt, and synthesize learned engineering skills to create microrobot.

CO3:	Model microrobots for different robotics applications.
CO4:	Formulate the specifications and design of mechatronic systems.
CO5:	Program the Microrobot for different robotics applications
CO6:	Communication between micro robots.
TEXT BOOKS:	
1.	Mohamed Gad-el-Hak , "The MEMS Handbook", 2nd Edition, CRC Press, New York, 2019.Yves Bellouard, "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2019
2.	Mohamed Gad-el-Hak , "The MEMS Handbook", 2nd Edition, CRC Press, New York, 2019. Yves Bellouard, "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2019
REFERENCE BOOKS:	
1.	NadimMaluf and KirtWilliams, "An Introduction to Microelectromechanical systems Engineering", 2nd edition, Artech House, 2004.
2.	Julian W Gardner, "Microsensors: Principles and Applications", 2nd edition, Wiley, 2007.
3.	MetinSitti, "Mobile Microrobotics", MIT Press, 2017.
4.	Nicolas Chaillet, Stephane Rangier "Microrobotics for Micromanipulation", John Wiley & Sons, 2013.

U23RAV14	AGRICULTURAL ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To learn about Farming related Machines.
2.	To understand the global position and information system in machines.
3.	To know about traction and testing
4.	To familiarize the concept on weed management
5.	To learn about machinery selection.

UNIT I	INTRODUCTION	9

History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot.

UNIT II	PRECISION AGRICULTURE	9

Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks

UNIT III	TRACTION AND TESTING	9

Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.

UNIT IV	SOIL TILLAGE AND WEED MANAGEMENT	9

Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation

UNITV	MACHINERY SELECTION	9

Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize the areas in agricultural process where robotics can be applied.
CO2 :	Integrate sensor and system for a required specific process in agricultural applications.
CO3:	Apply Mechanics to the design various robot parameters
CO4:	Convert various mechanisms into robot by providing actuation at specific links and joints of the mechanism.
CO5:	Develop suitable robotic system for specific agricultural tasks.

CO6:	Develop the economical and power analysis for an agricultural robotic system
TEXT BOOKS:	
1.	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2.	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.
REFERENCE BOOKS:	
1.	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2.	Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3.	R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi, 2005.
4.	Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.

U23RAV15	COLLABORATIVE ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To know the fundamentals of Collaborative Robotics
2.	To introduce Swarm robot and trajectory planning for Swarm
3.	To introduce Modular Robotics and its Mechanics
4.	To learn about various Natural models of robot collaboration
5.	To introduce the concept of Reconfigurable robot

UNIT I	INTRODUCTION TO COBOTICS	9

Collaborative Robotics- Properties - Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators-Current Challenges.

UNIT II	PRECISION AGRICULTURE	9

Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT III	MODULAR ROBOTICS	9

Module Designs - Modular Robot Representation -Modular Serial Robot Kinematics - Kinematic Calibration for Modular Serial Robots- Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics

UNIT IV	NATURALLY INSPIRED COLLABORATION	9

Collective Decision-Making. Group Decision Making in Animals, Collective Motion as Decision Process, Models for Collective Decision-Making Processes, Urn Models, Voter Model, Majority Rule, Hegselmann and Krause , Kuramoto Model , Axelrod Model, Ising Model, Fiber Bundle Model, Sznajd Model, Bass Diffusion Model, Sociophysics and Contrarians .

UNITV	RECONFIGURABLE ROBOTS	9

V-Shaped Formation Control for Robotic Swarms Constrained by Field of View – formation of reconfigurable virtual linkage - Reconfigurable Formation Control of Multi-Agents - Self-Assembly Modular Robot Platform Based on Sambot - Swarm Dynamics Emerging from Asymmetry.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize the fundamentals of Collaborative Robotics
CO2 :	Apply Swarm robots technology in real time applications.
CO3:	Analyze and select the suitable concept of Modular Robotics and its Mechanics for modelling a collaborative robot
CO4:	Create various Natural models for robot collaboration
CO5:	Develop collaborative robots for various requirement in industrial tasks.
CO6:	Develop a new model of reconfigurable robots.

TEXT BOOKS:	
1.	Guilin Yang, I-Ming Chen, “Modular Robots: Theory and Practice”, Springer, 2022.
2.	Giandomenico Spezzano, “Swarm Robotics”, Applied Sciences, MDPI, 2019.
REFERENCE BOOKS:	
1.	Heiko Hamann, “Collective Decision-Making in Swarm Robotics: A Formal Approach”, Springer, 2019.

U23RAV16	HUMANOID ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To know the basic knowledge about Humanoid robots.
2.	To impart knowledge in kinematics of humanoids.
3.	To learn about the dynamics in humanoid robots.
4.	To understand the basic in biped walking.
5.	To know about the different walking patterns.

UNIT I	INTRODUCTION	9

Historical development of Humanoids, Human Likeness of a Humanoid Robot, Trade-Offs in Humanoid Robot Design, Human-Friendly Humanoid Robot Design, characteristics of humanoid robots.

UNIT II	KINEMATICS	9

Kinematic structure, forward and inverse kinematic problems, differential kinematics, Twist, Spatial Velocity, and Spatial Transform, Inverse Differential Kinematic Relations. Differential kinematics at singular configurations- Gait Analysis.

UNIT III	ZMP AND DYNAMICS	9

ZMP Overview,2D Analysis,3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot, ZMP for Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motion and Ground Reaction Force , Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body, Calculation of Robot's Center of Mass, Link Speed and Angular Velocity, Calculation of Robot's Momentum and Angular Momentum

UNIT IV	BIPED WALKING	9

Two Dimensional Walking Pattern Generation, Two Dimensional Inverted Pendulum, Behaviour of Linear Inverted Pendulum, Orbital Energy, Support Leg Exchange, Planning a Simple Biped Gait, Extension to a Walk on Uneven Terrain.

UNITV	WALKING PATTERN GENERATION	9

ZMP Based Walking Pattern Generation, Cart-Table Model, Off-Line Walking Pattern Generation, Stabilizer, Principles of Stabilizing Control, Stabilizing Control of Honda Humanoid Robot, Advanced Stabilizers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Describe about the evolution of Humanoid robots
CO2 :	Expose the basic knowledge in kinematics of humanoids.
CO3:	Calculate the Humanoid Robot Motion and Ground Reaction Force.
CO4:	Identify Two-Dimensional Walking pattern on different terrain.
CO5:	Create the Walking Pattern models.
CO6:	Describe a suitable walking pattern for an real time robot model.

TEXT BOOKS:	
1.	Dragomir N. Nenchev, Atsushi Konno, “Humanoid Robots Modeling and Control”, Butterworth Heinemann, 2019
2.	Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH ”Introduction to Humanoid Robotics”, Springer, London, 2014.
3.	Goswami Ambarish, Vadakkepat Prahlad, "Humanoid Robotics: A Reference", Springer, 2019.
4.	J. Craig, "Introduction to Robotics: Mechanics and Control", Fourth Edition, Pearson, 2022
REFERENCE BOOKS:	
1.	A. Goswami, P. Vadakkepat (Eds.), “Humanoid Robotics: A Reference”, Springer, Netherlands, Dordrecht, 2018
2.	J K. Harada, E. Yoshida, K. Yokoi (Eds.), “Motion Planning for Humanoid Robots”, Springer, London, 2010
3.	Lorenzo Sciavicco and Bruno Siciliano, "Modelling and Control of Robot Manipulators", second edition, Springer, 2000
4.	Jean-Claude Latombe, "Robot Motion Planning", Kluwer Academy Publishers, 2004s

U23RAV17	MEDICAL ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Identify and describe different types of medical robots and their potential applications.
2.	Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
3.	Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.
4.	Be familiar with the state of the art in applied medical robotics and medical robotics research.
5.	Understand the various roles that robotics can play in healthcare.

UNIT I	INTRODUCTION	9

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – State of art of robotics in the field of healthcare-DICOM

UNIT II	LOCALIZATION AND TRACKING	9

Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.

UNIT III	DESIGN OF MEDICAL ROBOTS	9

Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security.

UNIT IV	SURGICAL ROBOTICS	9

Minimally invasive surgery and robotic integration - surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopaedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery - case studies

UNITV	ROBOTS IN REHABILITATION AND MEDICAL CARE	9

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots - Robots in Physiotherapy - case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Identify various medical robots and their potential applications
CO2 :	Recognize the position tracking and hybrid systems.
CO3:	Apply Robotics and its concepts in Medical field
CO4:	Simulate a MIS procedure and be aware of the state of art in surgical and oncology robotics.
CO5:	Design a medical robotic system given the specific requirements for Rehabilitation and Medical care.
CO6:	Identify various application of robots in medical field.

TEXT BOOKS:	
1.	Achim Ernst Floris Schweikard, "Medical Robotics", Springer, 2016.
2.	Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2013.
REFERENCE BOOKS:	
1.	Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2019.
2.	Jocelyne Troccaz , "Medical Robotics", John Wiley & Sons Incorporated, 2013.
3.	Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.
4.	Farid Gharagozloo "Robotic Surgery", Springer, 2022.

VERTICALS – II (MANUFACTURING SYSTEMS)

U23RAV18	ROBOT OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce ROS and programming
2.	To develop the Robot environment
3.	To obtain the simulation robots in ROS with GAZEBO
4.	To simulate robots with V-Rep
5.	To understand mapping, navigation and motion planning ROS with Move-it

UNIT I	ROS ESSENTIALS	9

Introduction to ROS- Advantages and Disadvantages of ROS - ROS Framework- ROS package C++, Python – ROS computation Graph – nodes, Messages, topics, services, bags, ROS Master- ROS Community- Basic programming and Syntax overview in C++ and Python – start with ROS programming - Creating Environment - Services-Actions and Nodes- Simple Interaction with the Simulation environment

UNIT II	BUILD YOUR OWN ROBOT ENVIRONMENT	9

CAD Tools for Robot Modelling – ROS Packages for robot modelling – Unified Robot Description Format and Tags- Kinematics and Dynamics Library – Create URDF Model - Robot Modelling using Unified Robot Description Format (URDF),-ROS parameter server and adding real-world object representations to the simulation environment _ Create Robot description using 7 DOF: joint number, name, type and angle limits – Xacro – Rviz – viewing of 7 DOF arm – creation of wheeled robot

UNIT III	SIMULATION ROBOTS IN ROS WITH GAZEBO	9

Robot simulation - Gazebo –create simulation model at Gazebo- Adding colors, textures, transmission tags, 3D vision sensor to Gazebo- Moving robot joints using ROS controllers- ROS controller interacts with Gazebo, interfacing state controller, simulation of moving the robot joints – simulation of differential wheeled robot in Gazebo.

UNIT IV	ROS WITH VREP	9

V-REP is a multi-platform robotic simulator - Simulating the robotic arm using V-REP - Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, Adding a laser sensor , 3D vision sensor

UNITV	MAPPING, NAVIGATION AND MOTION PLANNING ROS WITH MOVEIT	9

Move it Instattion - Generating the Self-Collision matrix .virtual joints, planning groups, robot poses, robot end effector - MoveIt Architecture Diagram - Trajectory from RViz GUI executing in Gazebo -Planning scene overview diagram- Collision Checking - Motion Planning, Pick and Place Behaviours using Industrial Robots with ROS Moveit – ROS with MATLAB - ROS with Industrial

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Recognize the concept of ROS and programming.
CO2 :	Evaluate various robot algorithms in ROS programming.
CO3:	Simulate robots in ROS with GAZEBO and V-REP.
CO4:	Program a Robot using ROS and its tool boxes.
CO5:	Deploy mapping, navigation and motion planning ROS with Move-it
CO6:	Create a robot program and simulation for a specific robot application.
TEXT BOOKS:	
1.	Lentin Joseph, Jonathan Cacace, "Mastering ROS for Robotics Programming", Second Edition, Packt Publishing, 2018.
REFERENCE BOOKS:	
1.	Lentin Joseph, Aleena Johny, "Robot Operating System (ROS) for Absolute Beginners Robotics Programming Made Easy", Second Edition, Apress, 2022.
2.	Lentin Joseph, "ROS Robotics Projects", Packt publishing, 2017

U23RAV21	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To provide the overview of evolution of automation, CIM and its principles.
2.	To learn the various Automation tools, include various material handling system.
3.	To train students to apply group technology and FMS.
4.	To familiarize the computer aided process planning in manufacturing.
5.	To introduce to basics of data transaction, information integration and control of CIM.

UNIT I	INTRODUCTION	9

CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Role of management in CAM, Concepts of Computer Integrated Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions.

UNIT II	INTRODUCTION OF CIM	9

CIM concepts, Computerized elements of CIM system, Types of production - Manufacturing models and Metrics Mathematical models of Production Performance, Lean Production and Just-In-Time Production.

UNIT III	INTEGRATED PRODUCTION MANAGEMENT SYSTEM	9

Introduction, PPC fundamentals, Problems with PPC, MRP-I, MRP-II. Just in Time philosophy: JIT & GT applied to FMS, concepts of Expert System in Manufacturing and Management Information System.

UNIT IV	GROUP TECHNOLOGY AND CAPP	9

Introduction, part families, part classification and coding systems: OPITZ, PFA, FFA, Cell design, rank order clustering, composite part concepts, Benefits of group technology. Approaches to Process Planning, Different CAPP system, application and benefits.

UNITV	CELLULAR MANUFACTURING	9

Production flow Analysis, Cellular Manufacturing, Composite part concept, Machine cell design and layout , Quantitative analysis in Cellular Manufacturing, Rank Order Clustering Method - Arranging Machines in a GT cell.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Students will describe basic concepts of CAM application and understand CAM wheel
CO2 :	Student will identify application of PPC, JIT, MRP-I, MRP-II, and Expert system to CAM
CO3:	Students will classify different components using different techniques of group technology
CO4:	Determine the various CAPP approaches.
CO5:	Determine the production flow analysis and cellular manufacturing
CO6:	Students will identify the rank order cluster method.

TEXT BOOKS:	
1.	Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover, Pearson Education
2.	Robotics Technology and Flexible Automation, by S R Deb, S Deb, McGraw Hill Education Private Limited
3.	Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
4.	CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.
REFERENCE BOOKS:	
1.	CAD/CAM‖ by Ibrahim Zeid, Tata McGraw Hill.
2.	Principles of Computer Integrated Manufacturing, S.Kant Vajpayee, 1999, Prentice Hall of India, New Delhi.

U23RAV22	ADVANCED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	The objective of this course is to teach the lean tools to attain optimum level in quality.
2.	To enhance the ability to make decisions for new product development.
3.	Aims to develop the students to conserve energy and natural resources, and to ensure that they have minimal impact on the environment and society.
4.	To give students an introduction to an advanced information process technique.
5.	To learn about the various smart manufacturing techniques and applications.

UNIT I	INTRODUCTION TO LEAN MANUFACTURING	9

Objectives of lean manufacturing-key principles and implications of lean manufacturing -traditional Vs lean manufacturing- flow-continuous improvement/Kaizen –worker involvement- 5S principles elements of JIT - uniform production rate - Kanban system - Lean implementation, Reconciling lean with other systems - lean six sigma- lean and ERP - lean with ISO 9001:2000.

UNIT II	AGILE MANUFACTURING	9

Agile Manufacturing Vs Mass Manufacturing - Agile practice for product development - Manufacturing agile practices - Implementing new technology - A checklist, technology applications that enhance agility - agile technology make or buy decisions. - Costing for Agile Manufacturing practices.

UNIT III	SUSTAINABLE MANUFACTURING	9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs

UNIT IV	INTELLIGENT MANUFACTURING	9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNITV	SMART MANUFACTURING	9

Introduction to various Smart Manufacturing Techniques - Supply chain management -Block chain of inventory management - Plant digitization - Predictive maintenance-Supply chain visibility-Warehouse-Cost reduction-Waste management-Automated systems-Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Demonstrate on basic lean manufacturing.
CO2 :	Integrate the knowledge on agile manufacturing.

CO3:	Formulate strategy in sustainable manufacturing.
CO4:	Apply artificial intelligence (AI) and fuzzy techniques to improve the efficiency of manufacturing systems.
CO5:	Exposure to smart manufacturing and its various techniques.
CO6:	Integrate the knowledge Predictive maintenance and Waste management.

TEXT BOOKS:	
1.	Lonnie Wilson, "How to Implement Lean manufacturing", McGraw-Hill Professional; 2nd edition, 2015.
2.	Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
3.	Kusiak, Andrew, "Intelligent Manufacturing Systems", Prentice Hall, 1st edition, 1990.
REFERENCE BOOKS:	
1.	Black .J.T. and Kohser R.A, "DeGarmo's Materials and Processes in Manufacturing", Published by Wiley, 11th edition, 2011.
2.	Christian N. Madu, "Handbook of environmentally conscious manufacturing", Springer US Publishers, 1st edition, 2001.
3.	John Schey, "Introduction to Manufacturing Processes", Tata McGraw-Hill Education ,3rd edition,1999

U23RAV23	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
2.	To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
3.	To be acquainted with vat polymerization and direct energy deposition processes
4.	To be familiar with powder bed fusion and material extrusion processes.
5.	To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes

UNIT I	INTRODUCTION	9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing- Electronics Printing. Business Opportunities and Future Directions.

UNIT II	DESIGN FOR ADDITIVE MANUFACTURING	9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

UNIT III	VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION	9

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology.
Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery - Materials -Benefits -Applications.

UNIT IV	POWDER BED FUSION AND MATERIAL EXTRUSION	9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

UNITV	OTHER ADDITIVE MANUFACTURING PROCESSES	9

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.
Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
CO2 :	Acquire knowledge on process of transforming a concept into the final product in AM technology.
CO3:	Elaborate the vat polymerization and direct energy deposition processes and its applications.
CO4:	Acquire knowledge on process and applications of powder bed fusion and material extrusion.
CO5:	Evaluate the advantages, limitations, applications of binder jetting and material jetting
CO6:	Evaluate the advantages, limitations, applications sheet lamination processes

TEXT BOOKS:	
1.	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2.	Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

REFERENCE BOOKS:	
1.	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2.	Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3.	Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4.	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5.	Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011, ISBN: 9780849334092.

U23RAV24	COMPUTER AIDED INSPECTION AND TESTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To familiar the measurement standards and to know the instruments used and various errors in measurements
2.	To recognize the use of basic and advanced instruments for measurements.
3.	To learn the applications of opto-electronics device for measurements.
4.	To describe the various measurement techniques using laser metrology.
5.	To gain knowledge on computer aided inspection and advances in metrology.

UNIT I	FUNDAMENTALS AND CONCEPTS IN METROLOGY	9

Standards of Measurement – Analog and Digital Measuring Instruments - Comparators – Limits, Fits and Tolerances – Gauge Design –Surface Roughness – Form Errors and Measurements.

UNIT II	INSPECTION AND GENERAL MEASUREMENTS	9

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 - Inspection of Gears And Threads - Tool Makers' Microscope – Universal Measuring Machine.

UNIT III	OPTO ELECTRONICS IN ENGINEERING INSPECTION	9

Use of Optoelectronics in Tool Wear Measurements – Microhole Measurement and Surface Roughness – Applications in In-Process Measurement and On-Line Inspection

UNIT IV	LASER METROLOGY	9

Precision instrument based on Laser - Use of Lasers - Principle –Interferometers, Interference microscope -Optical flats - Laser Interferometer - Application in Linear and Angular measurements - Testing of machine tools using Laser Interferometer. Use of Laser Interferometer in Machine Tool Inspection – Uses of Laser in On-Line Inspection – Laser Micrometer – Laser Alignment Telescope.

UNITV	COMPUTER AIDED INSPECTION AND ADVANCES IN METROLOGY	9

Co-ordinate Measuring Machines - Constructional features - Types - Applications of CMM - CNC CMM applications - Measurement arms, Laser tracker - Fundamentals of Computer Aided Inspection - Introduction to Nano metrology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Practice the standards in measurements and to avoid the various forms of errors in measurements.
CO2 :	Use of basic and advanced metrology instruments for measurements.
CO3:	Acquire the knowledge on non-contact opto-electronics device for measurements.
CO4:	Describe various measurement techniques using laser metrology.

CO5:	Recognize the computer aided inspection and advances in metrology.
CO6:	Acquire the knowledge on fundamentals of Nano Metrology.
TEXT BOOKS:	
1.	Anil. K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt. Ltd., 2006.
2.	Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, 2002.
3.	Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2014.
REFERENCE BOOKS:	
1.	Charles Reginald Shotbolt, "Metrology for Engineers", Cengage Learning EMEA,5th edition, 1996.
2.	Jain R.K., "Engineering Metrology", Khanna Publishers, 2012.
3.	Robert G. Seippel, "Opto-Electronics for Technology and Engineering", Prentice Hall, 1989.
4.	Robert J. Hocken, Paulo H. "Coordinate Measuring Machines and Systems", CRC Press, 2nd edition, 2016.

U23RAV25	RELIABILITY AND MAINTENANCE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To impart knowledge about basic concepts of reliability
2.	To learn about various models of reliability
3.	To know about maintenance functions and objectives, maintenance planning and scheduling, maintenance organization.
4.	To impart knowledge about Principles of CBM, pillars of condition monitoring, CBM implementation and benefits
5.	To learn about reliability centered maintenance, TPM and FMECA

UNIT I	BASIC CONCEPTS OF RELIABILITY	9

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 II	SYSTEM RELIABILITY MODELS	9

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 III	MAINTENANCE CONCEPTS AND STRATEGIES	9

Use of Optoelectronics in Tool Wear Measurements – Microhole Measurement and Surface Roughness – Applications in In-Process Measurement and On-Line Inspection

UNIT IV	CONDITION BASED MAINTENANCE	9

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

UNITV	RELIABILITY CENTERED MAINTENANCE (RCM)	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize about basic concepts of reliability
CO2 :	Know about the various models of reliability
CO3:	Apply the various maintenance functions and objectives, maintenance planning

	and scheduling, maintenance organization.
CO4:	Demonstrate Principles of CBM, pillars of condition monitoring, CBM implementation.
CO5:	Apply the reliability centred maintenance, TPM and FMECA.
CO6:	Apply the reliability centred maintenance in real time industrial problems.
TEXT BOOKS:	
1.	Ebeling CE; An Introduction To Reliability & Maintainability Engg McGraw Hill Education; 12th edition , 2017
2.	Srinath L.S; Reliability Engineering; East West Press, 2005
REFERENCE BOOKS:	
1.	Naikan, V.N.A., Reliability engineering and life testing; PHI,2008
2.	Kapur KC and Lamberson LR; Reliability in Engineering Design; Wiley India 1997
3.	Telang AD and Telang A; Comprehensive Maintenance Management; PHI
4.	Mishra R.C; Reliability and Maintenance Engineering; New age International publisher 2006.
5.	Balaguruswamy,E., Reliability Engg; TMH,2017

U23RAV26	CNC MACHINE TOOLS AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	Explain the mechanics of metal cutting and the factors affecting machinability
2.	Explain the working of basic and advanced turning machines.
3.	Teach the basics of machine tools with reciprocating and rotating motions and abrasive finishing processes.
4.	Explain the constructional features of CNC machine tools.
5.	Explain the basics of CNC programming and the machine tools through planning, writing codes and ,setting up CNC machine tools

UNIT I	MECHANICS OF METAL CUTTING	9

Mechanics of chip formation, forces in machining, types of chip, cutting tools – Single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT II	TURNING MACHINES	9

Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes - tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle.

UNIT III	RECIPROCATING MACHINE TOOLS	9

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation - Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding - micro finishing methods

UNIT IV	CNC MACHINES	9

Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centers - Work holding methods in Turning and machining centers, Coolant systems, Safety features.

UNITV	PROGRAMMING OF CNC MACHINE TOOLS	9

Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Analyse the mechanics of metal cutting process and to identify the factors

	involved in improving machinability.
CO2 :	Understand the constructional features and working principles of basic and advanced turning machines.
CO3:	Evaluate and select suitable machining operation to manufacture a given component.
CO4:	Understand the constructional features and working principles of CNC machine tools.
CO5:	Program CNC machine tools through planning.
CO6:	writing codes and setting up CNC machine tools to manufacture a given component

TEXT BOOKS:	
1.	Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education 8th Edition, 2022.
2.	Michael Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Education;4th edition, 2019.

REFERENCE BOOKS:	
1.	Roy. A. Lindberg, "Processes and materials of manufacture", Pearson India Education Services Pvt. Ltd, 4th edition, 2015.
2.	Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1985.
3.	Rao. P.N, "Manufacturing Technology Volume 2, Metal Cutting and Machine Tools", McGraw- Hill, New Delhi, 3rd edition, 2013.
4.	Peter Smid, "CNC Programming Handbook", Industrial Press Inc., 3rd edition, 2007.
5.	A. B. Chattopadhyay, "Machining and Machine Tools", Wiley, 2nd edition, 2017.

U23RAV27	ADVANCED MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To classify non-traditional machining processes and describe mechanical energy based non-traditional machining processes.
2.	To differentiate chemical and electro chemical energy-based processes.
3.	To describe thermo-electric energy-based processes
4.	To explain nano finishing processes.
5.	To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes

UNIT I	INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES	9

Introduction, Need for non-traditional machining processes, Classification of non-traditional machining processes, Applications, advantages and limitations of non-traditional machining processes, Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II	CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES	9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring.

UNIT III	THERMO-ELECTRIC ENERGY BASED PROCESSES	9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT IV	NANO FINISHING PROCESSES	9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

UNITV	HYBRID NON-TRADITIONAL MACHINING PROCESSES	9

Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Formulate different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.
CO2 :	Illustrate chemical and electro chemical energy based processes.
CO3:	Evaluate thermo-electric energy based processes.

CO4:	Interpret nano finishing processes.
CO5:	Analyse hybrid non-traditional machining processes and differentiate non-traditional machining processes.
CO6:	Create a new hybrid non-traditional machining processes.
TEXT BOOKS:	
1.	Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458
2.	Ana nd Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.
REFERENCE BOOKS:	
1.	Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
2.	Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3.	Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3- 319-52008-7.
4.	Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5.	Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN- 13: 978-3319259208.

U23RAV28	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To study the fundamental concept and principles of industrial safety.
2.	To study the principles of maintenance engineering.
3.	To Analyzing the wear and its reduction.
4.	To study the faults in various tools, equipments and machines.
5.	To study the periodic maintenance procedures in preventive maintenance.

UNIT I	INDUSTRIAL SAFETY	9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II	MAINTENANCE ENGINEERING	9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III	WEAR AND CORROSION AND THEIR PREVENTION	9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods

UNIT IV	FAULT TRACING	9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor.

UNITV	PERIODIC AND PREVENTIVE MAINTENANCE	9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Explain the fundamental concept and principles of industrial safety.
CO2 :	Apply the principles of maintenance engineering.
CO3:	Analyze the wear and its reduction.

CO4:	Evaluate faults in various tools, equipment and machines.
CO5:	Apply periodic maintenance procedures.
CO6:	Apply preventive maintenance procedures.

TEXT BOOKS:	
1.	L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2.	Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.

REFERENCE BOOKS:	
1.	Edward Ghali, V. S. Sastri, M. Elboujdaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007.
2.	Garg, HP, Maintenance Engineering, S. Chand Publishing.
3.	J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
4.	R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
5.	W. E. Vesely, F. F. Goldberg, Fault Tree Handbook, Create space Independent Pub, 2014

VERTICALS – III (SMART MOBILITY SYSTEMS)

U23RAV31	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To study the construction and working principle of various parts of an automobile.
2.	To study the practice for assembling and dismantling of engine parts and transmission system
3.	To study various transmission systems of automobile.
4.	To study about steering, brakes and suspension systems
5.	To study alternative energy sources

UNIT I	VEHICLE STRUCTURE AND ENGINES	9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components-functions and materials, variable valve timing (VVT).

UNIT II	ENGINE AUXILIARY SYSTEMS	9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT III	TRANSMISSION SYSTEMS	9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS),electronic brake force distribution (EBD) and Traction Control.

UNITV	ALTERNATIVE ENERGY SOURCES	9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell. Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize the various parts of the automobile and their functions and materials.

CO2 :	Discuss the engine auxiliary systems and engine emission control
CO3:	Distinguish the working of different types of transmission systems.
CO4:	Explain the Steering, Brakes and Suspension Systems.
CO5:	Predict possible alternate sources of energy for IC Engines.
CO6:	Dismantling and assembling of Engine parts and Transmission Systems

TEXT BOOKS:	
1.	Jain K.K. and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
2.	Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.

REFERENCE BOOKS:	
1.	Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012.
2.	Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
3.	Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.
4.	Martin W, Stockel and Martin T Stockle , "Automotive Mechanics Fundamentals," The Good heart - Will Cox Company Inc, USA ,1978.
5.	Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers,1989.

U23RAV32	AUTOMOTIVE MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	The intention and purpose of this course is to study the basics of electronics, emission controls and its Importance in automobiles.
2.	To study the Ignition and Injection system in Automobiles
3.	To study the various sensors and actuators used in automobiles for improving fuel economy and emission control.
4.	To study the various blocks of mechatronic control units used for control of fuel, ignition and exhaust systems.
5.	To learn about different types of chassis and mechatronics safety systems in automobile.

UNIT I	INTRODUCTION	9

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards. Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits.

UNIT II	IGNITION AND INJECTION SYSTEMS	9

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT III	SENSOR AND ACTUATORS IN AUTOMOTIVES	9

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator.

UNIT IV	ENGINE CONTROL SYSTEMS	9

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU's used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles.

UNITV	CHASSIS AND SAFETY SYSTEMS	9

Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Know the importance of emission standards in automobiles.
CO2 :	Understand the electronic fuel injection/ignition components and their function.
CO3:	Choose and use sensors and equipment for measuring mechanical quantities,

	temperature and appropriate actuators.
CO4:	Diagnose electronic engine control systems problems with appropriate diagnostic tools.
CO5:	Analyze the chassis and vehicle safety system.
CO6:	Understand the climate control system.

TEXT BOOKS:	
1.	Ribbens, "Understanding Automotive Electronics", 8th Edition, Elsevier, Indian Reprint, 2017.
REFERENCE BOOKS:	
1.	Barry Hollembeak, “Automotive Electricity, Electronics & Computer Controls”, Delmar Publishers, 7th edition, 2019.
2.	Richard K. Dupuy “Fuel System and Emission controls”, Check Chart Publication,4th edition, 2000.
3.	Ronald. K. Jurgon, “Automotive Electronics Handbook”, McGraw-Hill, 1999.
4.	Tom Denton, “Automobile Electrical and Electronics Systems”, Edward Arnold Publishers, 2000.

U23RAV33	SMART MOBILITY AND INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2.	To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
3.	To learn Basic Control System Theory applied to Autonomous Automobiles.
4.	To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
5.	To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT I	INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES	9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.

UNIT II	SENSOR TECHNOLOGY FOR SMART MOBILITY	9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems.

UNIT III	CONNECTED AUTONOMOUS VEHICLE	9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.

UNIT IV	VEHICLE WIRELESS TECHNOLOGY & NETWORKING	9

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.

UNITV	CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY	9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles- Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles
CO2 :	Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing.
CO3:	Familiar with the concept of fully autonomous vehicles.
CO4:	Apply the basic concepts of wireless communications and wireless data networks
CO5:	Analyze the concept of the connected vehicle.
CO6:	Explain the role of automated vehicles.

TEXT BOOKS:	
1.	1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2.	Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer
REFERENCE BOOKS:	
1.	Tom Denton, "Automobile Electrical and Electronic systems, Roult edge", Taylor & Francis Group, 5th Edition, 2018.

U23RAV34	ELECTRIC AND HYBRID VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To Acquire knowledge on general aspects of Electric and Hybrid Vehicles (EHV).
2.	To Acquire knowledge on sources of energy and Battery Management
3.	To Get the idea on driver assistance technology.
4.	To learn overview of power convertors and controllers.
5.	To impart knowledge on Electric and Hybrid Vehicles (EHV).

UNIT I	DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES	9

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

UNIT II	ENERGY SOURCES	9

Battery Parameters - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

UNIT III	OVERVIEW OF DRIVER ASSISTANCE TECHNOLOGY	9

Basics of Theory of Operation, Applications, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion. Vehicle Prognostics Technology

UNIT IV	POWER CONVERTERS AND CONTROLLERS	9

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

UNIT V	HYBRID AND ELECTRIC VEHICLES	9

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand the operation and architecture of electric and hybrid vehicles
CO2 :	Identify various energy source options like battery and fuel cell
CO3:	Select suitable electric motor for applications in hybrid and electric vehicles.
CO4:	Explain the role of power electronics in hybrid and electric vehicles .
CO5:	Analyze the energy and design requirement for hybrid and electric vehicles
CO6:	Understand Economical analysis of Hybrid vehicles.

TEXT BOOKS:	
1.	Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2.	Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.
REFERENCE BOOKS:	
1.	James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2.	Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3.	Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

U23RAV35	AIRCRAFT MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the basic of avionics and its need for civil and military aircrafts
2.	To impart knowledge about the avionic architecture and various avionics data bases
3.	To gain more knowledge on various avionics subsystems
4.	To impart knowledge on aircraft materials.
5.	To analyse the application of Mechatronics in aircraft.

UNIT I	AIRCRAFT AERODYNAMICS	9

Nomenclature used in Aerodynamics, different parts of airplane- Wing as lifting surface, Types of wing plan forms, Aerodynamic features like Aerofoil pressure distribution- Aerodynamic forces and moments Lift and Drag- Drag polar, L/D ratio, high lift devices, Airplane performance like Thrust/Power available, climb and glide - maximum range and endurance, take off and landings.

UNIT II	AIRCRAFT PROPULSION	9

Requirement of power- various means of producing power - Brief description of thermodynamics of engines - Piston engines, Jet engines - Airplane Structure, Materials and Production - Structural arrangement of earlier airplane- developments leading to all metal aircraft - Strength to weight ratio choice of aircraft materials for different parts.

UNIT III	AIRCRAFT MATERIALS	9

Detailed description of wing - tail and fuselage joints - Stress-Strain diagrams, Plane and Space, Mechanical properties of materials - Materials for different components - use of composites - Aircraft production methods and equipment.

UNIT IV	PRIMARY FLIGHT CONTROLS	9

Ailerons - Aileron Control System of a Commercial Aircraft - Elevators - Elevator control system of a commercial aircraft – Rudders- Rudder Control System

UNITV	APPLICATIONS OF MECHATRONICS IN AVIATION	9

Aileron-Flaps and Actuator drive unit-Pilot Static system-Fly by wire control system-Yaw damper-Primary flight control system-Internal navigation system-Under carriage-Measurement of motor rpm-Measurement of air flow velocity-Altitude measurement sensor-Air speed.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize the Basics in aerodynamics, aircraft propulsion, materials and controls
CO2 :	Know about the various concepts used in aerodynamics
CO3:	Apply the techniques to develop the aero system
CO4:	Design the aircraft with the use of concepts
CO5:	Apply this aircraft system in various applications
CO6:	Know about the various applications of mechatronics in aviation.

TEXT BOOKS:	
1.	Fundamentals of Flight; By Dr. O. P. Sharma and Lalit Gupta.2006
2.	Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
REFERENCE BOOKS:	
1.	Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2.	Pallet. E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
3.	Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
4.s	Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000

U23RAV36	NAVIGATION AND COMMUNICATION SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce various types of navigation systems.
2.	To understand the dead reckoning navigation system and its error correction.
3.	To know satellite navigation and hybrid navigation system integration
4.	To learn the concepts of radio transmitters and receivers
5.	To acquire knowledge about weather radar systems and DME

UNIT I	INERTIAL NAVIGATION SYSTEMS	9

Introduction to navigation – Types -INS components- transfer function and errors - Earth in inertial space - Coriolis Effect – INS Mechanization. Platform and Strap down – Navigation algorithms - INS system block diagram, Different co-ordinate systems – Transformation Techniques - Schuler Tuning - compensation errors - Gimbal lock - Initial calibration and Alignment Algorithms.

UNIT II	RADIO NAVIATION & SATELLITE NAVIGATION	9

Different types of radio navigation- ADF, VOR, DME - Doppler – Hyperbolic Navigations - LORAN, DECCA and Omega – TACAN. Introduction to GPS -system description -basic principles -position and velocity determination signal Structure -DGPS, Introduction to Kalman filtering- Estimation and mixed mode navigation Integration of GPS and INS-utilization of navigation systems in aircraft.

UNIT III	RADIO TRANSMITTERS AND RECEIVERS	9

Functions of a Radio transmitter, Microphones, types, Block diagram explanation of a Radio transmitter, Modulation and its types and Antenna, Antenna couplers, Qualities of a good Radio receiver, Block diagram of a simple radio receiver and super heterodyne receiver.

UNIT IV	AIRCRAFT COMMUNICATION SYSTEMS	9

Basics of aircraft communication system, types Very High Frequency Communication system, Description, Principle, Operation of VHF Communication system and its layout on aircraft, High Frequency communication system, Description, Principle and operation of High Frequency communication system and its layout on aircraft. Satellite communication system, Description, Operation and its layout on aircraft.

UNITV	WEATHER RADAR SYSTEM AND DME	9

Introduction, Description and types of Radar, Primary and Secondary Radar, Weather Radar Description, Analog radar Principal units of Analog radar system. Aircraft weather radar, transmitter-receiver, Indicator, Control panel, Antenna, Radome and wave guide. Radome maintenance and radar safety.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Students will understand the advanced concepts of Aircraft Navigation
CO2 :	To provide the necessary mathematical knowledge those are needed in modeling the navigation process and methods.

CO3:	The students will have an exposure on various Navigation systems such as Inertial Measurement systems, Radio Navigation Systems, Satellite Navigation – GPS.
CO4:	Landing aids and will be able to deploy these skills effectively in the analysis and understanding of navigation systems in an aircraft.
CO5:	Learn and apply the principles of Radar and its related components.
CO6:	Learn and apply the principles of weather Radar and its related components.

TEXT BOOKS:	
1.	Aircraft Communications and Navigation systems – Mike Tooley and David Wyatt, Reed Elsevier, India, Noida, Edition – 2007)

REFERENCE BOOKS:	
1.	Aircraft Electricity and electronics by Thomas K Eismin (Fifth edition-1994, McGraw- Hill Book Co)
2.	Aircraft Radio system by James Powell, Sterling book house, Mumbai, Indian edition - 2006.

U23RAV37	AVIONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the basic of avionics and its need for civil and military aircrafts
2.	To impart knowledge about the avionic architecture and various avionics data buses
3.	To gain more knowledge on various avionics subsystems
4.	To understand the concepts of navigation systems.
5.	To gain knowledge on auto pilot system

UNIT I	INTRODUCTION TO AVIONICS	9

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.

UNIT II	DIGITAL AVIONICS ARCHITECTURE	9

Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629.

UNIT III	FLIGHT DECKS AND COCKPITS	9

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

UNIT IV	INTRODUCTION TO NAVIGATION SYSTEMS	9

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

UNITV	AIR DATA SYSTEMS AND AUTO PILOT	9

Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Built Digital avionics architecture.
CO2 :	Design Navigation system.
CO3:	Integrate avionics systems using data buses.
CO4:	Analyze the performance of various cockpit display technologies.
CO5:	Design autopilot for small aircrafts using MATLAB.
CO6:	Analyze the air data system.

TEXT BOOKS:

1.	Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
2.	Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.

REFERENCE BOOKS:	
1.	Aircraft Electricity and electronics by Thomas K Eismin (Fifth edition-1994, McGraw- Hill Book Co)
2.	Aircraft Radio system by James Powell, Sterling book house, Mumbai, Indian edition - 2006.
3.	Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
4.	Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000

U23RAV38	ADVANCED DRIVER ASSISTANCE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce students with various fundamentals related to advanced driver assistance technologies
2.	To impart knowledge on sensors, control and actuation methodologies and create impact of automating vehicles
3.	To acquire skills on vehicle prognostics and impaired driver technology
4.	To learn about various commonly available Advanced Driver Assistance Systems.
5.	To study about Center Console Technology and other display technology

UNIT I	AUTOMOTIVE FUNDAMENTALS	9

Power System-Running System-Comfort System– Engine Components – Drive train – suspension system, ABS, Steering System.

UNIT II	AUTOMOTIVE SENSORS	9

Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensors – operation, types, characteristics, advantage and their applications. Radar, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera

UNIT III	OVERVIEW OF DRIVER ASSISTANCE TECHNOLOGY	9

Basics of Theory of Operation, Applications, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion. Vehicle Prognostics Technology

UNIT IV	ADVANCED DRIVER ASSISTANCE SYSTEMS	9

Advanced Driver Assistance Systems - Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic

UNITV	ADAS DISPLAY & IMPAIRED DRIVER TECHNOLOGY	9

Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, and Warning Technology – Driver Notification. Impaired Driver Technology -Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize the rational for and evolution of automotive electronics
CO2 :	Know about the various automotive functions and sensors.
CO3:	Familiar with the theory and operation of legacy, new, and emerging ADAS systems and proposed autonomous vehicle systems

CO4:	Fundamentals of sensor data fusion as it relates to ADAS
CO5:	Apply possible evolution of vehicle prognostics and impaired driver technology
CO6:	Identify various commonly available Advanced Driver Assistance Systems for a specific application.
TEXT BOOKS:	
1.	Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group, 5th Edition,2018.
2.	William B Ribbens, "Understanding Automotive Electronic: An Engineering Perspective", Elsevier Science,8th Edition,2017.
REFERENCE BOOKS:	
1.	"Intelligent Transportation Systems and Connected and Automated Vehicles", Transportation Research Board, 2016.
2.	Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", Springer, 2019.

VERTICALS – IV (AUTOMATION)

U23RAV41	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the various applications of power electronic devices for conversion, control and conditioning of the electrical power and to get an overview of different types of power semiconductor devices and their dynamic characteristics
2.	To understand the operation, characteristics and performance parameters of controlled Rectifiers
3.	To study the operation, switching techniques and basic topologies of DC-DC switching regulators.
4.	To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
5.	To study the operation of AC voltage controller and various configurations of AC voltage controller.

UNIT I	SWITCHING POWER SUPPLIES	9

MOSFET dynamic behaviour - driver and snubber circuits - low power high switching frequency switching Power supplies, buck, boost, buck-boost converters – Isolated topologies – resonant converters - switching loss calculations and thermal design.

UNIT II	INVERTERS	9

IGBT: Static and dynamic behavior - single phase half bridge and full bridge inverters - VSI :(1phase and three phase inverters square wave operation) - Voltage control of inverters single, multi pulse, sinusoidal, space vector modulation techniques– various harmonic elimination techniques-CSI

UNIT III	UNCONTROLLED RECTIFIERS	9

Power Diode – half wave rectifier – mid-point secondary transformer based full wave rectifier – bridge rectifier – voltage doubler circuit – distortion factor – capacitor filter for low power rectifiers – LC filters – Concern for power quality – three phase diode bridge.

UNIT IV	CONTROLLED RECTIFIERS	9

SCR-Two transistor analogy based turn- ON – turn ON losses – thermal protection – controlled converters (1 pulse, 2 pulse, 3 pulse, 6 pulse) - displacement factor – ripple and harmonic factor - power factor mitigation, performance parameters – effect of source inductance - inverter angle limit.

UNIT V	AC PHASE CONTROLLERS	9

TRIAC triggering concept with positive and negative gate pulse triggering, TRIAC based phase controllers - various configurations for SCR based single and three phase controllers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Understand the operation of semiconductor devices and dynamic characteristics and to design &analyze the low power SMPS
CO2 :	Analyze the various uncontrolled rectifiers and design suitable filter circuits
CO3:	Analyze the operation of the n-pulse converters and evaluate the performance parameters
CO4:	Understand various PWM techniques and apply voltage control and harmonic elimination methods to inverter circuits.
CO5:	Understand the operation of AC voltage controllers and its applications.
CO6:	Understand the various configurations of AC voltage controller.

TEXT BOOKS:	
1.	Ned Mohan, T.M.Undeland, W.P.Robbins, ”Power Electronics: Converters, applications and design”, John Wiley and Sons, 3rd Edition (reprint), 2009
2.	Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India, 3rd Edition, New Delhi, 2004.

REFERENCE BOOKS:	
1.	P.C.Sen, Power Electronics, Tata McGraw-Hill, 30th reprint, 2008.
2.	Philip T.Krein, Elements of Power Electronics, Oxford University Press, 2013.

U23RAV42	OBJECT ORIENTED PROGRAMMING IN C++	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the basics in OOPS and control structures
2.	To Know about the various functions in C++
3.	To obtain the knowledge in Constructors and Deconstructors
4.	To understand the concepts in pointers, virtual functions and polymorphism
5.	To aware of the modelling and abstraction models

UNIT I	PRINCIPLES OF OOPS AND CONTROL STRUCTURES	9

Object Oriented Programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of Object Oriented Programming, Object Oriented Languages, Applications of Object Oriented Programming, Beginning with C++,Tokens, Keywords, Identifiers and Constants, Data Types, Type Compatibility, Variables, Operators in C++,Implicit Conversions, Operator Overloading, Operator Precedence, Control Structures.

UNIT II	FUNCTIONS IN C++, CLASSES AND OBJECTS	9

The Main Function, Function Prototyping, Call by Reference, Return by Reference, Inline Functions, Function Overloading, Friend and Virtual Functions. Specifying a class, Member Functions, Arrays within a class, Static Member Functions, Arrays of Objects, Friendly Functions.

UNIT III	CONSTRUCTORS AND DESTRUCTORS, OPERATORS BOVERLOADING	9

Constructors, Parameterized Constructors, Copy Constructors, Dynamic Constructors, Destructors, Defining Operator Overloading, Overloading Operators, Rules for Overloading Operators, Type Conversions

UNIT IV	POINTERS, VIRTUAL FUNCTIONS AND POLYMORPHISM	9

Pointers, Pointers to Objects, this pointer, Pointer to Derived Classes, Virtual Functions, Classes for File Stream Operations, Opening and Closing a File, File Modes, File Pointers, Input Output Operations, Updating a File

UNIT V	DEVELOPMENT	9

Object Orientation O Development O Themes, Modelling, Abstraction Models.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Master the fundamental principles of OO programming, Master key principles in OO analysis, design, and development.
CO2 :	Be familiar with the application of the Unified Modeling Language (UML) towards analysis and design
CO3:	Master common patterns in OO design and implement them

CO4:	Be familiar with alternative development processes and be familiar with group/team projects and presentations.
CO5:	Be exposed to technical writing and oral presentations.
CO6:	Be familiar with modelling and abstraction models

TEXT BOOKS:	
1.	James Rumbaugh ,"Object Oriented Modelling and Design" , Pearson publication,1991
2.	Robert Lafore ,"Object-oriented programming in Turbo C++", Galgotia Publication,2004.
REFERENCE BOOKS:	
1.	E.Balagurusamy , "Object-oriented programming with C++", 8th Edition, TMH.,2021
2.	Philip T.Krein, Elements of Power Electronics, Oxford University Press, 2013.

U23RAV43	COMPUTER ARCHITECTURE AND ORGANIZATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
2.	To study the general purpose architecture for computer system.
3.	To study the design of data path unit and control unit for ALU operation.
4.	Understanding the concept of various memories.
5.	To introduce the concept of interfacing and organization of multiple processors

UNIT I	INTRODUCTION	9

Computing and Computers, Evolution of Computers, VLSI Era, System Design- Register Level, Processor Level, CPU Organization, Data Representation, Fixed – Point Numbers, Floating Point Numbers, Instruction Formats, Instruction Types. Addressing modes.

UNIT II	DATA PATH DESIGN	9

Fixed Point Arithmetic, Addition, Subtraction, Multiplication and Division, Combinational and Sequential ALUs, Carry look ahead adder, Robertson algorithm, booth‘s algorithm, nonrestoring division algorithm, Floating Point Arithmetic, Coprocessor, Pipeline Processing, Pipeline Design, Modified booth‘s Algorithm.

UNIT III	CONTROL DESIGN	9

Hardwired Control, Micro programmed Control, Multiplier Control Unit, CPU Control Unit, Pipeline
Control, Instruction Pipelines, Pipeline Performance, Superscalar Processing, Nano Programming.

UNIT IV	MEMORY ORGANIZATION	9

Random Access Memories, Serial - Access Memories, RAM Interfaces, Magnetic Surface Recording, Optical Memories, multilevel memories, Cache & Virtual Memory, Memory Allocation, Associative Memory.

UNIT V	SYSTEM ORGANIZATION	9

Communication methods, Buses, Bus Control, Bus Interfacing, Bus arbitration, IO and system control, IO interface circuits, Handshaking, DMA and interrupts, vectored interrupts, PCI interrupts, pipeline interrupts, IOP organization, operation systems, multiprocessors, fault tolerance, RISC and CISC processors, Superscalar and vector processor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Comprehend and appreciate the significance and role of this course in the present contemporary world.
CO2 :	Describe data representation, instruction formats and the operation of a digital computer.

CO3:	Illustrate the data path unit and control unit for ALU operation.
CO4:	Discuss about implementation schemes of control unit and pipeline performance.
CO5:	Explain the concept of various memories, interfacing and organization of multiple processors.
CO6:	Discuss about the interrupts, I/O and other components of the system.

TEXT BOOKS:	
1.	John P. Hayes,, "Computer architecture and Organization", Tata McGraw-Hill, 3rd Edition, 1998.
2.	V. Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", 5th Edition, McGraw-Hill Inc, 1996.
REFERENCE BOOKS:	
1.	Morris Mano, "Computer System Architecture", Prentice-Hall ofIndia, 2000.
2.	Behrooz Paraami, "Computer Architecture, From Microprocessor to Supercomputers", Oxford University Press, Sixth impression, 2010.
3.	P. PalChaudhuri, "Computer organization and design", Prentice Hall of India, 2 nd Edition, 2007.

U23RAV44	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce virtual instrumentation concepts and applications.
2.	To train to program virtual instrumentation software for biomedical applications
3.	To understand the data acquisition and control in VI
4.	To obtain the knowledge in instrument interfaces
5.	To analyze the applications of VI in Bio Medical Engineering

UNIT I	INTRODUCTION	9

History of Virtual Instrumentation (VI), advantages, block diagram and architecture of a virtual instrument, Programming paradigms – Virtual Instrumentation – Lab VIEW software – Lab VIEW basics – Lab VIEW environment.

UNIT II	VI USING LABVIEW	9

Creating, Editing and debugging a VI in Lab VIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.

UNIT III	DATA ACQUISITION AND CONTROL IN VI	9

Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data acquisition – Simple problems

UNIT IV	INSTRUMENT INTERFACES	9

Current loop, RS 232C/RS 485, GPIB, System basics, Interface basics: USB, PCMCIA, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control. ADC, DAC, DIO, DMM, waveform generator.

UNIT V	APPLICATION OF VI IN BIOMEDICAL ENGINEERING	9

Design of virtual applications for Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	To comprehend and appreciate the significance and role of this course in the present contemporary world.
CO2 :	Identify salient traits of a virtual instrument
CO3:	Understand the use of VI for data acquisition.
CO4:	Experiment, analyze and document different types of interfaces.
CO5:	Apply the virtual instrumentation technologies for medical applications
CO6:	Design of virtual applications for a bio medical application.

TEXT BOOKS:	
1.	Gary Johnson, “LABVIEW Graphical Programming”, McGraw Hill, 4th edition,2006..
2.	Jerome, Jovitha, “Virtual Instrumentation and LABVIEW”, PHI Learning, New Delhi, 1st Edition, 2010.
3.	Sanjay Gupta and Joseph John, “Virtual Instrumentation using Lab VIEW”, Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st Edition, 2010.
REFERENCE BOOKS:	
1.	Technical Manuals for DAS Modules of Advantech and National Instruments.
2.	Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes, 2003.

U23RAV45	INDUSTRIAL NETWORK PROTOCOLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To study the various types wired protocols for electronic system.
2.	To know the various types wireless protocols for electronic system.
3.	To aware the various industrial wired protocols in automation.
4.	To study the various types wireless protocols for industrial automation.
5.	To develop the wired and wireless functions of various protocols.

UNIT I	WIRED BUSES AND PROTOCOLS	9

Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232-UARTSPI - I2C –UNI/O Bus -1 Wire -Camera Link - Parallel Communication -PPI - Wishbone Bus – AMBA – JTAG - Fireware IEEE 1394 Bus - Ethernet Overview - RS485

UNIT II	WIRELESS PROTOCOLS	9

Antenna Technology- Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless
Industrial Automation Protocols.

UNIT III	INDUSTRIAL AND AUTONOMOUS SYSTEMS WIRED NETWORKS	9

Overview of Industrial Wired Networks – Terminal Bus- Modbus - HART Network -Mechatrolink-II – EtherCAT- Sercos II/III – CAN- Canopen - Modbus IDA-PROFINET-PROFIBUS-Ethernet/IPEthernet Powerlink- AG Automation and Drives (AS-I) - Device Net

UNIT IV	INDUSTRIAL WIRELESS NETWORKS	9

Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks-Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.

UNIT V	APPLICATION OF COMMUNICATION PROTOCALS	9

Wired Machine Networking of Sub-elements and Machines - Wireless Machine Networking of Sub-elements and Machines – Networking of Industry - Communication Network Layout Design - Networking for TIA- Cloud Computing – IOT - Case Studies in Automation Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Design wired protocols for electronic system.
CO2 :	Use wireless protocols for electronic system.
CO3:	Practice industrial wired protocols in automation.
CO4:	Select wireless protocols for industrial automation.
CO5:	Demonstrate the wired and wireless functions of various protocols in application development.
CO6:	Explain applications of communication protocols.

TEXT BOOKS:	
1.	Borko Furht, “Encyclopaedia of Wireless and Mobile Communications - Three Volume Set”, CRC Press, 2012.
2.	Dick Caro, “Wireless Networks for Industrial Automation”, 2014.
REFERENCE BOOKS:	
1.	MMC-SD SERCOS Drive, “G&L Motion Control”, Hardware Manual, 2005
2.	Richard Zurawski, “Industrial Communication Technology”, CRC Press, 2017.
3.	Wolfram Behardt and Jorg Wollert, “The wireless B: Evolution and Communication”, Stetue Germany, 2016.

U23RAV46	MOTION CONTROL SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce the basics in motion control system.
2.	To knowledge about on architecture of motion control system.
3.	To understand the features and specifications in motion control drives.
4.	To learn about intelligent motors and integrated drive.
5.	To ability to know about the programming of motion controller.

UNIT I	INTRODUCTION MOTION CONTROL SYSTEMS	9

Introduction to Motion Control System - Dynamic System Modeling - Control System Design Fundamentals – Parameters in Control – Actuators and Measurement in Motion Control Systems - Multi-Body Dynamics – Need for Motion Controller – Specification of Motion Control

UNIT II	ARCHITECTURE OF MOTION CONTROL SYSTEM	9

Introduction to Motion Controller – Programmable Automation Controllers – Features & Specification of Motion Controllers – Digital I/O – Analog I/O – Standards in I/O – I/O Specific to Sensors – Modular and Expansion Concepts – Drives

UNIT III	MOTION CONTROL DRIVES	9

Programmable Automation Controllers – Features & Specification of Motion Controllers – Digital I/O – Analog I/O – Standards in I/O – I/O Specific to Sensors – Modular and Expansion Concepts - Drives

UNIT IV	INTELLIGENT MOTORS WITH INTEGRATED DRIVE	9

Intelligent motors – intelligent drives – features of drives – programmable I/Os- communication protocols – features – Software - Programming – current, position and speed loops – Application in robots and portable systems

UNIT V	PROGRAMMING OF MOTION CONTROLLER	9

IEC 61131 standards and Its Programming Languages overview- CoDeSys Platform – status Diagram – PLC Open - Motion Planer - PID - Servo Tuning – Position- velocity, Acceleration and Torque Profiling – CAM Profiling – Multi- Axis Motion Controllers – CNC Machines – Robot case study

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Know about the basics in motion control system
CO2 :	Obtain the knowledge on architecture of motion control system
CO3:	Analyze the features and specifications in motion control drives
CO4:	Obtain the concepts about on intelligent motors and integrated drive
CO5:	Understand the knowledge about the programming of motion controller
CO6:	Create a program of motion controller for a specific application.

TEXT BOOKS:	
1.	M. Nakamura .S. Gata & N. Kyura, Mechatronic Servo System Control, Springer, 2004
2.	Sabanovic Asif, Motion Control Systems, John Wiley & Sons Inc, 2011
REFERENCE BOOKS:	
1.	Operating instructions Compax3 T30 Programmable motion control according to IEC61131-3, Parker Hannifin Corporation, 2008.
2.	Technical Reference, IPOS4808 BX-CAT-STO Intelligent Servo Drive for Step, DC, Brushless DC and AC Motors, Techno soft, 2022.

U23RAV47	TOTAL INTEGRATED AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To gain knowledge in automation in industries.
2.	To gain knowledge in various electrical and electronic programmable automations and their applications.
3.	To gain knowledge in communication protocols in an integrated system
4.	To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
5.	To know about the advanced in automation industries.

UNIT I	TOTALLY INTEGRATED AUTOMATION	9

Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.

UNIT II	HUMAN MACHINE INTERFACE (HMI)	9

Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI- Text display - operator panels - Touch panels - Panel PCs - Integrated displays (PLC & HMI).

UNIT III	SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)	9

Overview – Developer and runtime packages – architecture – Tools – Tag – Internal &External graphics, Alarm logging – Tag logging – structured tags– Trends – history– Report generation, VB & C Scripts for SCADA application.

UNIT IV	COMMUNICATION PROTOCOLS OF SCADA	9

Proprietary and open Protocols – OLE/OPC- UPC UA/DA – DDE – Server/Client Configuration – Messaging – Recipe – User administration – Interfacing of SCADA with PLC, drive, and other field device

UNIT V	DISTRIBUTED CONTROL SYSTEMS (DCS0029)	9

DCS – architecture – local control unit- programming language – communication facilities – operator interface – engineering interfaces. APPLICATIONS OF PLC & DCS: Case studies of Machine automation, Process automation, Introduction to SCADA Comparison between SCADA and DCS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Knowledge of PLC & PAC automation
CO2 :	Knowledge in HMI systems and to integrate it with other systems.
CO3:	Ability to apply SCADA and usage of C programming for report generation
CO4:	Acquiring information's on communication protocols in automation systems
CO5:	Ability to design and develop automatic control system using distributed control systems.
CO6:	Knowledge in advanced in automation industries.

TEXT BOOKS:	
1.	John. W. Webb& Ronald A. Reis, “Programmable logic controllers: Principles and Applications”, Prentice Hall India, 2009.
2.	Michael P. Lukas, “Distributed Control systems”, “Van Nostrand Reinfold Company”1995 .
REFERENCE BOOKS:	
1.	Win C C Software Manual, Siemens, 2003
2.	RS VIEW 32 Software Manual, Allen Bradly, 2005
3.	CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004

U23RAV48	DIGITAL TWIN AND INDUSTRY 5.0	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To understand the basics concepts in digital twin
2.	To Introduce the concepts in digital twin in a discrete Industry
3.	To Introduce the concepts in digital twin in a process Industry
4.	To obtain the knowledge in industry 5.0
5.	To know about the advantages in industry 5.0

UNIT I	INTRODUCTION	9

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	DIGITAL TWIN IN A DISCRETE INDUSTRY	9

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	DIGITAL TWIN IN A PROCESS INDUSTRY	9

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	9

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	ADVANTAGES OF DIGITAL TWIN	9

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Analyze the basics concepts in digital twin
CO2 :	Recognize the concepts in digital twin in a discrete Industry
CO3:	Recognize the concepts in digital twin in a process Industry
CO4:	Obtain the knowledge in industry 5.0
CO5:	Apply the advantages in industry 5.0 with various applications.
CO6:	Apply the advantages in Digital twin with various applications.

TEXT BOOKS:	
1.	Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2018
2.	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019
REFERENCE BOOKS:	
1.	Uthayan Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2022.
2.	Ibrahim Garbie, “Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0”, Springer., Switzerland, 2016.
3.	Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018
4.	Ulrich Sendler, “The Internet of Things, Industries 4.0 Unleashed”, Springer., Germany, 2018

OPEN ELECTIVE

U23RAO11	INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To get a knowledge of working on Industrial robots and their load handling capacity
2.	To enlist with an application of robots in various operation
3.	To familiar with a material handling system
4.	To impart the knowledge on robotic welding
5.	To obtain the knowledge on various type of robot welding operation

UNIT I	INTRODUCTION	9

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell

UNIT II	SELECTION OF ROBOTS AND OTHER APPLICATIONS	9

Factors influencing the choice of a robot - robot performance testing - economics of robotisation - Impact of robot on industry and society. Application of Robots in continuous arc welding - Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.

UNIT III	MATERIAL HANDLING	9

Concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems (ASRS) - bar code technology - radio frequency identification technology.

UNIT IV	ROBOTIC WELDING	9

Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding.

UNITV	APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES	9

Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize various concepts of Industrial Robot.
CO2 :	Select the appropriate manufacturing procedure for Robots

CO3:	Apply various manufacturing process in Robot manufacturing.
CO4:	Learn about the Welding operation and also related to Programming
CO5:	Produce a manufacturing plan for developing a robot
CO6:	Apply Robot application in welding process in hazardous environment.

TEXT BOOKS:	
1.	Richard D Klafter, Thomas Achmielewski, MickaelNegin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2006.
2.	Mikell P Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2019.
3.	Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.
REFERENCE BOOKS:	
1.	Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013.
2.	John A. piotrowski, William T. Randolph , "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.
3.	Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, AshishDutta , "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2012.
4.	YoramKoren , "Robotics for Engineers", McGraw-Hill, 1987.

U23RAO12	ELEMENTS OF INDUSTRIAL AUTOMATION SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
2.	To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
3.	To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
4.	To learn about the fundamentals of Programmable Logic Controller.
5.	To familiarize the Data Communication and Supervisory Control Systems.

UNIT I	FLUID POWER SYSTEM GENERATION AND ACTUATORS	9

Need For Automation, Classification of Drives - Hydraulic, Pneumatic and Electric –Comparison – ISO Symbols for their Elements, Selection Criteria. Generating Elements- Hydraulic Pumps and Motor Gears, Vane, Piston Pumps – Motors - Selection and Specification - Drive Characteristics – Utilizing Elements - Linear Actuator – Types, Cushioning – Accumulators.

UNIT II	CONTROL AND REGULATIING ELEMENTS	9

Control and Regulating Elements — Direction, Flow and Pressure Control Valves -Methods of Actuation, Types, Sizing of Ports. Spool Valves - Operating Characteristics

UNIT III	CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS	9

Typical Design Methods - Sequencing Circuits Design - Combinational Logic Circuit Design - Cascade Method - KV Mapping - Electrical Control of Pneumatic and Hydraulic Circuits - Use of Relays, Timers, Counters and PLC in pneumatics and hydraulics

UNIT IV	PROGRAMMABLE LOGIC CONTROLLER	9

Industrial Automation - Programmable Logic Controller - Functions of PLCs - Features of PLC - Selection of PLC - Architecture - IEC61131-3 programming standard and types - Basics of PLC Programming - Ladder Logic Diagrams - Communication in PLC - Programming Timers and Counters - Data Handling - PLC modules - Advanced motion controlled Multi Axis PLC

UNITV	DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS	9

Industrial Data Communications - Modbus – HART – DeviceNet – Profibus – Fieldbus – RS232-RS485- Modbus/ Modbus TCP/IP– CAN – EtherCAT - Introduction to Supervisory - Control Systems – SCADA - Distributed Control System (DCS) – Safety Systems – human machineinterfaces - Total Integrated Automation (TIA) – Industry 4.0.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end ofthe course thestudentswouldbeableto	
CO1 :	Recognize the various concepts of fluid power and PLC systems.
CO2 :	Comprehend functions of fluid power and PLC systems.
CO3:	Explain the various standard fluid power circuits, functions, communication and IO details of PLC
CO4:	Demonstrate the standard fluid power circuits and PLC based interfaces.
CO5:	Construct the fluid power circuits and PLC based automation system.
CO6:	Demonstrate the Data Communication And Supervisory Control System

TEXT BOOKS:	
1.	Antony Esposito, “Fluid Power Systems and Control”, Prentice-Hall, 2006.
2.	Peter Rohner, “Fluid Power Logic Circuit Design”, the Macmillan Press Ltd., London, 1979.
3.	Frank D, Petruzella, “Programmable Logic Controller” McGraw – Hill Publications, Fourth Edition, 2016

REFERENCE BOOKS:	
1.	Lucas, M.P., “Distributed Control System”, Van Nastrand Reinhold Company, New York, 1986.
2.	Mackay S., Wrijut E., Reynders D. and Park J., “Practical Industrial Data Networks Design, Installation and Troubleshooting”, Newnes Publication, Elsevier, First Edition, 2004.
3.	Patranabis. D, “Principles of Industrial Instrumentation”, Tata McGraw-Hill Publishing Ltd., New Delhi, 1999.

U23RAO13	ROBOTICS IN AGRICULTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To learn about Farming related Machines.
2.	To understand the global position and information system in machines.
3.	To know about traction and testing
4.	To familiarize the concept on weed management
5.	To learn about machinery selection.

UNIT I	INTRODUCTION	9

History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot.

UNIT II	PRECISION AGRICULTURE	9

Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks

UNIT III	TRACTION AND TESTING	9

Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.

UNIT IV	SOIL TILLAGE AND WEED MANAGEMENT	9

Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation

UNITV	MACHINERY SELECTION	9

Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 :	Recognize the areas in agricultural process where robotics can be applied.
CO2 :	Integrate sensor and system for a required specific process in agricultural applications.
CO3:	Apply Mechanics to the design various robot parameters

CO4:	Convert various mechanisms into robot by providing actuation at specific links and joints of the mechanism.
CO5:	Develop suitable robotic system for specific agricultural tasks.
CO6:	Develop the economical and power analysis for an agricultural robotic system
TEXT BOOKS:	
1.	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2.	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.
REFERENCE BOOKS:	
1.	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2.	Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3.	R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi, 2005.
4.	Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.

U23RAO14	FOUNDATION OF ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To study the kinematics, drive systems and programming of robots.
2.	To study the basics of robot laws and transmission systems
3.	To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4.	To familiarize students with the various Programming and Machine Vision application in robots.
5.	To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

UNIT I	FUNDAMENTALS OF ROBOT	9

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

UNIT II	ROBOT KINEMATICS	9

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

UNIT III	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper.

UNIT IV	SENSORS IN ROBOTICS	9

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

UNITV	PROGRAMMING AND APPLICATIONS OF ROBOT	9

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Interpret the features of robots and technology involved in the control.
CO2 :	Apply the basic engineering knowledge and laws for the design of robotics.
CO3:	Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.
CO4:	Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.
CO5:	Interpret the sensor and it types and selection based on the application
CO6:	Explain the basic concepts of programming for an industrial application of a robot.
TEXT BOOKS:	
1.	Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2.	Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012.
REFERENCE BOOKS:	
1.	Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2.	YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3.	Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4.	John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5.	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

U23RAO15	SMART ROBOTICS TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1.	To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2.	To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
3.	To learn Basic Control System Theory applied to Autonomous Automobiles.
4.	To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
5.	To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT I	INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES	9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.

UNIT II	SENSOR TECHNOLOGY FOR SMART MOBILITY	9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems.

UNIT III	CONNECTED AUTONOMOUS VEHICLE	9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.

UNIT IV	VEHICLE WIRELESS TECHNOLOGY & NETWORKING	9

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.

UNITV	CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY	9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles- Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
At the end of the course the students would be able to	
CO1 :	Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles
CO2 :	Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing.
CO3:	Familiar with the concept of fully autonomous vehicles.
CO4:	Apply the basic concepts of wireless communications and wireless data networks.
CO5:	Analyze the concept of the connected vehicle.
CO6:	Explain the role of automated vehicles.
TEXT BOOKS:	
1.	1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2.	Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer
REFERENCE BOOKS:	
1.	Tom Denton, "Automobile Electrical and Electronic systems, Roult edge", Taylor & Francis Group, 5th Edition, 2018.