KUMARAGURU COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641049

REGULATION 2018A(R18A)

(2022 Batch onwards)

SYLLABUS

1st to 8thSemesters

BE MECHATRONICS ENGINEERING

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DEPARTMENT OF MECHATRONICS ENGINEERING

VISION

To achieve excel in academic and industrial automation research and innovative product development driven by mechatronics systems."

MISSION

- Impart the right blend of knowledge and skills to students and enable them to apply it in real life situations.
- Motivate the students towards interdisciplinary research to cater to the local and global needs.
- Achieve innovation in developing industrial products with social responsibility.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Mechatronics Engineering Undergraduate Program are to prepare the students:

I. To develop innovative and sustainable products with multidisciplinary Engineering expertise.

II. Solve intricate engineering problems by identifying the crux from the mechatronics engineering fundamentals and engage in lifelong learning in their profession.

III. To work or pursue higher education in multicultural, multilingual and multinational environment with competent oral and written communication.

IV. To lead and contribute in a team entrusted with professional, social and ethical responsibilities.

PROGRAM OUTCOMES (POs)

Graduates of the Mechatronics Engineering Undergraduate Program should have the ability to:

PO1: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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PO3: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.

PO4: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Create, select, and apply appropriate techniques, resources, and modem engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: 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: 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: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of the Mechatronics Engineering Undergraduate Program will have the ability to:

PSO1. Design and develop Mechatronics systems to solve complex engineering problems by integrating electronics, mechanical and computing systems.

PSO2. To analyze and provide solutions for real time engineering problems related to instrumentation, control, automation, and robotics.

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KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE – 641 049

REGULATIONS 2018

B.E. MECHATRONICS ENGINEERING

CURRICULUM

Semester I										Pre-requisite
S. No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18MAI1202	Linear Algebra and Calculus	Embedded - Theory & Lab	BS	3	0	2	0	4	-
2	U18CHI1202	Engineering Chemistry	Embedded - Theory & Lab	BS	3	0	2	0	4	-
3	U18ENI0201	Fundamental Communication	Embedded - Theory & Lab	HS	2	0	2	0	3	-
4	U18MEI1201	Engineering Graphics	Embedded - Theory & Lab	ES	2	0	2	0	3	-
5	U18CSI1201	Problem solving and Programming using C	Embedded - Theory & Lab	ES	2	0	2	0	3	-
6	U18INI1600	Engineering Clinic I	Practical and Project	ES	0	0	4	2	3	-
7.	U18TLR1001	Heritage of Tamils	Mandatory	HS	1	0	0	0	1*	
								Total Credits	21	
								Total Contact Hours/week	26	

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Semester II										Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18MAI2201	Advanced Calculus and Laplace Transforms	Embedded - Theory & Lab	BS	3	0	2	0	4	
2	U18PHI2202	Engineering Physics	Embedded - Theory & Lab	BS	3	0	2	0	4	-
3	U18*******	Language Elective	Embedded - Theory & Lab	HS	2	0	2	0	3	-
4	U18MET2003	Engineering Mechanics	Theory	ES	3	0	0	0	3	-
5	U18CSI2201	Python Programming	Embedded - Theory & Lab	ES	2	0	2	0	3	-
6	U18INI2600	Engineering Clinic II	Practical and Project	ES	0	0	4	2	3	-
7	U18TLR2001	Tamils and Technology	Mandatory	HS	1	0	0	0	1*	
Total Credits									21	
Total Contact Hours/week									27	

Semester III										Pre-requisite
S. No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18MAT3101	Partial Differential Equations and Transforms	Theory	BS	3	1	0	0	4	-
2	U18MCI3201	Electronic Devices and Circuits	Embedded - Theory & Lab	ES	3	0	2	0	4	-
3	U18MCI3202	Electrical Machines	Embedded - Theory & Lab	PC	3	0	2	0	4	-
4	U18MCT3103	Mechanics of solids	Theory	ES	3	1	0	0	4	-
5	U18MCT3104	Fluid Mechanics and Thermal Sciences	Theory	ES	3	1	0	0	4	-
6	U18INI3600	Engineering Clinic III	Practical and Project	ES	0	0	4	2	3	-
Total Credits									**23**	
Total Contact Hours/week									**28**	

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Semester IV										Pre-requisite
S. No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18MAT4101	Numerical Methods and Probability	Theory	BS	3	1	0	0	4	-
2	U18MCI4201	Hydraulics and Pneumatics	Embedded - Theory & Lab	PC	3	0	2	0	4	-
3	U18MCI4202	Sensors and Instrumentation	Embedded - Theory & Lab	PC	3	0	2	0	4	-
4	U18MCT4103	Digital Electronics and Microprocessor	Theory	PC	3	1	0	0	4	U18MCI3201
5	U18MCT4104	Theory of Machines	Theory	PC	3	1	0	0	4	-
6	U18INI4600	Engineering Clinic IV	Practical and Project	ES	0	0	4	2	3	-
7	U18CHT4000	Environmental Science and Engineering	Theory	MC	3	0	0	0	3	
8	U18VET4101	UHV-II	Theory	HS	2	1	0	0	3*	
Total Credits								**26**		
Total Contact Hours/week								**28**		
***Mandatory -Credit Course not for CGPA Calculation**										

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Semester V										Pre-requisite
S. No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	
1	U18MCI5201	Industrial Electronics and drives	Embedded - Theory & Lab	PC	3	0	2	0	4	U18MCI3202
2	U18MCI5202	Manufacturing Technology	Embedded - Theory & Lab	PC	2	0	2	0	3	-
3	U18MCI5203	Programmable logic controller	Embedded - Theory & Lab	PC	3	0	2	0	4	-
4	U18MCT5004	Control Engineering	Theory	PC	3	0	0	0	3	-
5	U18MCT5105	Design of Machine Elements	Theory	PC	3	1	0	0	4	U18MCT3103
6	U18MC00**	Open Elective I	Theory	OE	3	0	0	0	3	-
7	U18MCE00**	Professional Elective I	Theory	PE	3	0	0	0	3	-
Total Credits									**24**	
Total Contact Hours/week									**30**	

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Semester VI										Pre-requisite
S. No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18MCI6201	Computer aided Manufacturing	Embedded - Theory & Lab	PC	3	0	2	0	4	U18MCI5202
2	U18MCI6202	Robotics Engineering	Embedded - Theory & Lab	PC	3	0	2	0	4	-
3	U18MCI6203	Microcontroller and Embedded Systems	Embedded - Theory & Lab	PC	2	0	2	0	3	U18MCT4103
4	U18MCE00**	Professional Elective II	Theory	PE	3	0	0	0	3	-
5	U18MCE00**	Professional Elective III	Theory	PE	3	0	0	0	3	-
6	U18MCO0***	Open Elective II	Theory	OE	3	0	0	0	3	-
8	U18INT6000	Constitution of India	Theory	MC*						
								Total Credits	**20**	
								Total Contact Hours/week	**23**	

Semester VII										Pre-requisite
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18MBT7001	Engineering Economics and Financial Management	Theory	HS	3	0	0	0	3	-
2	U18MCT7001	Mobile Robotics	Theory	PC	3	0	0	0	3	-
3	U18MCT7002	Image Processing and Computer Vision	Theory	PC	3	0	0	0	3	-
4	U18MCE00**	Professional Elective IV	Theory	PE	3	0	0	0	3	-
5	U18MCE00**	Professional Elective V	Theory	PE	3	0	0	0	3	-
6	U18MCP7701	Project – Phase I	Project	PW	0	0	0	6	3	-
								Total Credits	18	
								Total Contact Hours/week	21	

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Semester VIII									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
1	U18MCP8701	Project – Phase II	Project	PW	0	0	0	24	12
								Total Credits	**12**
								Total Contact Hours/week	**24**
								Total Credits	**165**

Programme Electives									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
Mechatronics Systems									
1.	U18MCE0001	Automotive Electronics	Theory	PE	3	0	0	0	3
2.	U18MCE0002	Condition Monitoring	Theory	PE	3	0	0	0	3
3.	U18MCE0003	Micro Electro Mechanical Systems	Theory	PE	3	0	0	0	3
Computational Intelligence									
4.	U18MCE0004	Artificial Intelligence and Machine Learning	Theory	PE	3	0	0	0	3
5.	U18MCE0005	Database Management System	Theory	PE	3	0	0	0	3
6.	U18MCE0006	Soft Computing	Theory	PE	3	0	0	0	3
7.	U18MCE0014	Underwater Robotics	Theory	PE	3	0	0	0	3
Design and Manufacturing									
8.	U18MCE0007	Industrial IOT	Theory	PE	3	0	0	0	3
9.	U18MCE0008	Statistical Quality Control	Theory	PE	3	0	0	0	3
10.	U18MCE0009	Composite and Smart Materials	Theory	PE	3	0	0	0	3
11.	U18MCE0010	Additive Manufacturing	Theory	PE	3	0	0	0	3
12.	U18MCE0016	Finite Element Analysis	Theory	PE	3	0	0	0	3
Automation									
13.	U18MCE0011	Design of material handling systems	Theory	PE	3	0	0	0	3
14.	U18MCE0012	Design for manufacturing and Assembly	Theory	PE	3	0	0	0	3
15.	U18MCE0013	Precision manufacturing	Theory	PE	3	0	0	0	3
16.	U18MCE0015	Operation Research	Theory	PE	3	0	0	0	3
17.	U18MCE0017	Maintenance Engineering	Theory	PE	3	0	0	0	3
18.	U18MCE0018	Medical Mechatronics	Theory	PE	3	0	0	0	3

Open Electives									
S. No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
1.	U18MCO0001	Robotics for Engineers	Theory	OE	3	0	0	0	3
2.	U18MCO0002	Automation in Agriculture	Theory	OE	2	0	1	0	3
3.	U18MCO0004	Nature Inspired Optimization Techniques	Theory	OE	3	0	0	0	3
4.	U18MCO0005	Mechanics in Cricket	Theory	OE	3	0	0	0	3
5.	U18MCO0006	Low Cost Automation	Theory	OE	3	0	0	0	3
6.	U18MCO0007	Magics and Mechanics	Theory	OE	2	0	1	0	3

INDUSTRY OFFERING ELECTIVE									
1	U18MCE0019	Product Design and Development	Theory	PE	2	0	2	0	3
2	U18MCE0020	Product Lifecycle Management	Theory	PE	3	0	0	0	3
3	U18ECE0057	Introduction to HMI	Theory	PE	3	0	0	0	3
4.	U18ECE0058	Advanced HMI	Theory	PE	2	0	2	0	3

ONE CREDIT COURSE									
1	U18MCC0001	Robot Operating System	Practical	OC	1	0	0	0	1

Language Elective									
S.No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**
1.	U18FRI2201	French Level I	Theory	LE	2	0	2	0	3
2.	U18GEI2201	German Level I	Theory	LE	2	0	2	0	3
3.	U18HII2201	Hindi Level I	Theory	LE	2	0	2	0	3
4.	U18JAI2201	Japanese Level I	Theory	LE	2	0	2	0	3

NPTEL COURSES									
1	U18MCE0021	Surface Engineering of Nano materials	Theory	PE	2	0	0	0	2
2	U18MCE0022	Fundamentals of Automotive systems	Theory	PE	3	0	0	0	3
3	U18MCE0023	Structural Analysis of Nanomaterials	Theory	PE	1	0	0	0	1

Minor specialization in 3D Printing										Pre-requisite
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18MCR0001	Fundamentals of 3D printing	Embedded - Theory & Lab	ES	3	0	2	0	4	-
2	U18MCR0002	Additive manufacturing processes	Theory	ES	3	0	0	0	3	U18MCR0001
3	U18MCR0003	Mechatronics in 3D Printing	Embedded - Theory & Lab	ES	3	0	2	0	4	U18MCR0002
4	U18MCR0004	3D Printing laboratory	Laboratory	ES	0	0	2	0	2	U18MCR0002
5	U18MCR0005	Project	Project	PW	0	0	0	6	5	-
Total Credits									18	

MINOR SPECIALISATION CURRICULUM

Minor Specialization in Robotics										Pre-requisite
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	
1	U18MCR0008	Fundamentals of Robotics	Embedded - Theory & Lab	MS	2	0	2	0	3	-
2	U18MCR0009	Introduction to single-board microcontroller and Computer	Embedded - Theory & Lab	MS	2	0	2	0	3	U18MCR0008
3	U18MCR0010	Autonomous Mobile Robot	Embedded - Theory & Lab	MS	2	0	2	0	3	U18MCR0008
4	U18MCR0011	Industrial Robotics	Embedded - Theory & Lab	MS	2	0	2	0	3	-
5	U18MCR0012	Capstone Project	Project	PW	0	0	0	0	6	-
Total Credits									18	

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HONOR VERTICALS

Vertical 1: Applied Robotics									
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C
1	U18MCR0013	Robots and Systems in Smart Manufacturing	Theory	ES	3	0	0	0	3
2	U18MCR0014	Agricultural Robotics and Automation	Theory	ES	3	0	0	0	3
3	U18MCR0015	Humanoid Robotics	Theory	ES	3	0	0	0	3
4	U18MCR0016	Medical Robotics	Theory	ES	3	0	0	0	3
5	U18MCR0017	UAV systems	Theory	ES	3	0	0	0	3
6	U18MCR0018	Collaborative Robotics	Theory	ES	3	0	0	0	3
7	U18MCR0019	Microrobotics	Theory	ES	3	0	0	0	3
8	U18MCR0020	Motion simulation and virtual reality	Theory	ES	3	0	0	0	3

Vertical 2: Industrial Automation									
S.No	Course code	Course Title	Course Mode	CT	L	T	P	J	C
1	U18MCR0021	Smart Manufacturing & Automation	Theory	ES	3	0	0	0	3
2	U18MCR0022	Automation in production systems and Management	Theory	ES	3	0	0	0	3
3	U18MCR0023	Advanced SCADA,HMI and VFD	Theory	ES	3	0	0	0	3
4	U18MCR0024	Industrial Controller Communications	Theory	ES	3	0	0	0	3

5	U18MCR0025	Virtual Instrumentation	Theory	ES	3	0	0	0	3
6	U18MCR0026	Digital Twin and Industry 5.0	Theory	ES	3	0	0	0	3
7	U18MCR0027	Robotic Process Automation	Theory	ES	3	0	0	0	3
8	U18MCR0028	Supply chain management in industry 4.0	Theory	ES	3	0	0	0	3

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SEMESTER I

U18MAI1202	LINEAR ALGEBRA AND CALCULUS (Common to All branches except AI &DS)	L	T	P	J	C
		3	0	2	0	4

COURSE OUTCOMES

After successful completion of this course, the students should be able to:

CO1: Identify eigenvalues and eigenvectors, apply Cayley Hamilton theorem to Matrix. Manipulation and apply orthogonal diagonalization to convert quadratic form to canonical form.
CO2: Apply suitable techniques of differentiation and integration to various functions and identify the maxima and minima of functions of one variable.
CO3: Solve first order ordinary differential equations and apply them to certain physical situations.
CO4: Solve higher order ordinary differential equations arising in real world situations.
CO5: Evaluate the total derivative of a function, expand the given function as series and locate the maximum and minimum for multivariate functions.
CO6: Determine Rank, Inverse, Eigenvalues, Eigenvectors of the given matrix, solve. Differential equations and locate Maxima-Minima of the function using MATLAB

Pre-requisite: Basics of Matrices, Differentiation and Integration

CO/PO Mapping
S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	1	2
CO1	S	S												
CO2	S	M												
CO3	S	M												
CO4	S	M			M									
CO5	S	S												
CO6					S							M		

Course Assessment methods:

DIRECT

1. Continuous Assessment Test I, II (Theory component)
2. Open Book Test; Cooperative Learning Report, Assignment; Journal Paper Review, Group Presentation, Project Report, Poster Preparation, Prototype or Product
3. Demonstration etc (as applicable) (Theory component)
4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)
5. Model Examination (lab component)

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6. End Semester Examination (Theory and lab components)
INDIRECT
1. Course-end survey

THEORY COMPONENT

MATRICES	**11 Hours**
Rank of a matrix – Consistency of a system of linear equations - Rouche's theorem - Solution of a system of linear equations - Linearly dependent and independent vectors – Eigenvalues and Eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors – Cayley Hamilton theorem (excluding proof) - Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation	

DIFFERENTIAL AND INTEGRAL CALCULUS	**9 Hours**
Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable - Definite and Indefinite integrals - Techniques of Integration: Substitution rule, Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction.	

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS	**6 Hours**
Leibnitz's equation – Bernoulli's equation – Applications: Orthogonal trajectories and Electric Circuits	

HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS	**9 Hours**
Linear equations of second and higher order with constant coefficients – Euler's and Legendre's linear equations – Method of variation of parameters – First order Simultaneous linear equations with constant coefficients – Applications: Electric Circuits.	

FUNCTIONS OF SEVERAL VARIABLES	**10 Hours**
Total derivative – Taylor's series expansion – Maxima and minima of functions of two variables – Constrained maxima and minima: Lagrange's multiplier method with single constraints – Jacobians	

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2014.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Kreyzig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley and sons, 2011.

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REFERENCES

1. Veerarajan T., "Engineering Mathematics (for First Year)", Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007.
2. Weir, MD, Hass J, Giordano FR, "Thomas' Calculus", Pearson education 12th Edition, 2015.
3. G.B. Thomas and R.L. Finney, "Calculus and Analytical Geometry", 11th Edition, Pearson Education, 2006.
4. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.

WEBSITES

1. https://www.khanacademy.org/math/integral-calculus

LAB COMPONENT **30 Hours**

List of MATLAB Programs:

1. Introduction to MATLAB.
2. Matrix Operations - Addition, Multiplication, Transpose, Inverse
3. Rank of a matrix and solution of a system of linear equations
4. Characteristic equation of a Matrix and Cayley-Hamilton Theorem.
5. Eigenvalues and Eigenvectors of Higher Order Matrices
6. Curve tracing
7. Differentiation and Integration
8. Solving first and second order ordinary differential equations.
9. Determining Maxima and Minima of a function of one variable.
10. Determining Maxima and Minima of a function of two variables.

Theory: 45 **Tutorial: 0** **Practical: 30** **Project: 0** **Total: 75 Hours**

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U18CHI1202	ENGINEERING CHEMISTRY (Common to All Branches)	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1:	Apply the basic principles of chemistry at the atomic and molecular level.
CO2:	Analyze the impact of engineering solutions from the point of view of chemical principles
CO3:	Apply the chemical properties to categorize the engineering materials and their uses
CO4:	Integrate the chemical principles in the projects undertaken in field of engineering and technology
CO5:	Develop analytical proficiency through lab skill sets to demonstrate in professional practice.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M												
CO2	S	M		M										
CO3	S	M		S										
CO4	S	M		S										
CO5	M	S		S										

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment TestI 2. Continuous Assessment TestII 3. Assignment 4. End Semester Examination	1. Course-end survey

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ELECTROCHEMISTRY AND CORROSION	9 Hours
Electrodes - Calomel and Glass electrode (Construction and working principles) - Electrode Potential – Nernst equation and problems - Electrochemical Series and its applications. Corrosion: Mechanism of chemical and electrochemical corrosion - Types of corrosion (Metallurgically Influenced Corrosion, Mechanically Assisted Degradation and Environmentally Induced Cracking – overview) - Factors influencing corrosion. Corrosion control: Inhibitors – Cathodic protection (Sacrificial anodic protection, Impressed current cathodic protection) – Electroplating (Cu) and Electroless plating (Ni).	
SURFACE CHEMISTRY AND CATALYSIS	**8 Hours**
Adsorption: Types and factors affecting adsorption – Adsorption isotherms: Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Applications of adsorption on pollution abatement. Surface catalysis: Power law and Eley Rideal model and Langmuir-Hinshelwood mechanism. Catalysis: Catalyst – catalytic poisoning and catalytic promoters - autocatalysis –- acid base catalysis – enzyme catalysis. Applications of catalysis in industries.	
ENGINEERING MATERIALS	**8 Hours**
Polymers: Introduction – Degree of polymerization – Functionality – Preparation, Properties and Applications of PET, PVC and conducting polymers (Polyactylene and Polythiophene). Composites: Constituents of Composites and applications – Polymer Composites (PC) - Metal Matrix Composites (MMC) - Ceramic Matrix Composites (CMC) Lubricants: Classification (liquid, solid and semi solid) - Functions - Properties (viscosity index, flash and fire point, oiliness, carbon residue, aniline point, cloud point and pour point) – Synthetic lubricants.	
CHEMICAL BONDING	**7 Hours**
Introduction – Types of bonding: Ionic, covalent, co-ordinate and metallic bonds - Van der Waal's forces of attraction and its types (dipole - dipole, dipole - induced dipole, induced dipole - induced dipole) - hydrophobic interaction - hybridization in organic molecules (sp, sp^2, sp^3) - hydrogen bonding and its characteristics.	
THERMODYNAMICS	**7 Hours**
Introduction - Thermodynamic process – Internal energy – Enthalpy – First law of thermodynamics – Second law of thermodynamics - Entropy - Free Energy – Helmoltz Work Function - Gibbs Helmholtz equation - Problems – Clausius-Clapeyron equation – Maxwell's relations - Third law of thermodynamics – Zeroth law.	
WATER TECHNOLOGY	**6 Hours**
Introduction - Hardness of water - Disadvantages of hard water in boilers: scale and sludge, priming and foaming, caustic embrittlement and boiler corrosion - Softening of hard water: External treatment (Demineralization process) - Internal treatment (colloidal, carbonate, phosphate and Calgon conditioning) - Desalination (Reverse osmosis, Electrodialysis) – Domestic water treatment.	
Theory: 45 Tutorial: 0 Practical: 0 Project: 0	**Total: 45 Hours**

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REFERENCES

1. Jain P.C. and Jain. M., Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, Reprint 2017.
2. Puri B.R., Sharma L.R., Pathania, M.S. Principles of physical chemistry, Vishal Publishing Co., 2017
3. Atkins, P. and de Paula, J., Atkin's Physical Chemistry, 9th ed., Oxford Univ. Press, 2009.
4. Glasstone S., An introduction to Electrochemistry, 10th Edition, Affiliated to East West Press Private Limited, 2007.
5. Samir Sarkar., Fuels and Combustion, 3rd Edition, Orient Longman, India, 2009.
6. Dara S.S. and Umare S.S., A text book of Engineering Chemistry, S.Chand and Company Limited, New Delhi, 2014.
7. Engineering Chemistry, Wiley India Editorial Team, Wiley, 2018.

LABORATORY COMPONENT

LIST OF EXPERIMENTS (Any 10 - Branch specific)

1. Preparation of Standard solutions
2. Conductometric estimation of mixture of acids vs strong base
3. Estimation of extent of corrosion of Iron pieces by Potentiometry
4. Estimation of the extent of dissolution of Copper / Ferrous ions by spectrophotometry.
5. Estimation of acids by pH metry.
6. Determination of total, temporary and permanent hardness by EDTA method.
7. Estimation of DO by Winkler's method
8. Estimation of Alkalinity by Indicator method.
9. Estimation of Chloride by Argentometric method
10. Estimation of Sodium and Potassium in water by Flame photometry.
11. Determination of Flash and Fire point of lubricating oil
12. Determination of Cloud and Pour point of lubricating oil
13. Determination of relative and kinematic viscosities of lubricating oil at different temperatures
14. Determination of corrosion rate on mild steel by Weight loss method
15. Morphological studies of corrosion on mild steel by microscopic techniques

Theory: 0 Tutorial: 0Practical: 30 Project: 0 Total: 30 Hours

REFERENCES

1. Jeffery G.H., Bassett J., Mendham J. and Denny R.C., Vogel's Text Book of Quantitative Chemical Analysis, Oxford, ELBS, London,2012.
2. Shoemaker D.P. and C.W. Garland., Experiments in Physical Chemistry, Tata McGraw-Hill Pub. Co., Ltd., London,2003.

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U18ENI0201 - FUNDAMENTALS OF COMMUNICATION

(Common to all branches of B.E /B.Tech Programmes except AI &DS)

(For students admitted from the academic year 2022 - 2023)

L	T	P	J	C
2	0	2	0	3

Course Objectives:

1. To strengthen theory and practice of writing and speaking in academic context.
2. To hone written and spoken competencies leading to effective communication.
3. To comprehend, use and explain technical data and information.
4. To facilitate the application of advanced writing strategies in professional scenario.
5. To enhance the use of rhetorical strategies in professional situation.

Course Outcomes:

After the course, the student will be able to:

CO1: Read, listen, understand, and interpret material on technology.

CO2: Communicate knowledge and information through oral and written medium.

CO3: Reflect on effective use of formats and tactics in writing and speaking.

Assessment Methods

Direct
1. Continuous Assessment of Skills 2. Assignment 3. Written Test 4. End Semester Examination
Indirect
1. Course-end survey

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Dr. Arokia Lawrence Vijay, M.A.,M.Phil.,Ph.D.,
Assistant Professor III & Head
Department of Languages and Communication
Kumaraguru College of Technology

CO/PO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation)S-Strong, M-Medium, W-Weak														
COs	Programme Outcomes(POs)												PSO	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1		M		M					S	S		S		
CO2		M		M					S	S		S		
CO3		M		M					S	S		S		

UNIT - 1 12

Describing a place, event - Preparing Brochures, Flyers, Handouts (Layout & Content) - Drafting a proposal for an event - Writing Circular, Agenda, Minutes of Meeting

Listening: Listening to Presentation with Numerical Data - Listening to Presentation

Speaking: Picture Connect (Narrating story)

UNIT - 2 12

Transcoding Graphics (Graphs, Charts, Tables, Process Writing) - Writing a Report (Industry Accident, College Event) - Drafting permission letter and report for Industrial Visit, In-Plant Training) -Email Writing

Listening: Listening to Advertisement - Listening to Product Descriptions

Speaking: Extempore

UNIT - 3 12

Reading Reviews - Review Writing (Movie, Product, Short Story, Article) - Writing a Company Profile - Cover Letter and Resume Writing, Creating Online Profile -

Listening: Listening to Interviews

Speaking: Situational Discussion (Pair Activity)

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Dr. Arokia Lawrence Vijay, M.A.,M.Phil.,Ph.D.,
Assistant Professor III & Head
Department of Languages and Communication
Kamaraguru College of Technology
Tamil Nadu, India

UNIT - 4 12

Aptitude Questions Practice (Synonyms, Antonyms, Jumbled Sentences, Verbal Analogies) - General Interview Questions (Goal setting, strength and weakness, contribution to society / nation, narrating transformation of challenges into opportunities)

Listening: Listening to Panel / Group Discussion

Speaking: Event Management (Group Activity)

UNIT - 5 12

Problem Solving and Caselets / Case Studies -Creating Promotional Video - Hands-on training on PPT Preparation - Creating Advertisements

Listening: Listening to TED / TECH Talks - Listening to Success Stories

Speaking: Group Discussion (Interview Based)

Reference Books:

1. *Effective Technical Communication*, by Ashraf Rizvi, Tata McGraw Hill Publications.
2. *Technical Communication – English Skills for Engineers,* by Meenakshi Raman & Sangeeta Sharma, Oxford Higher Education.
3. *Talk like TED,* by Carmine Gallo, St. Martin's Press.
4. *Basic Communication Skills for Technology,* by Andrea J Rutherfoord, Pearson Publishers.
5. *Word Power Made Easy*, by Norman Lewis, Simon and Schuster.
6. *Life Skills and Leadership for Engineers*, by David Goldsberg, University of Skinois, Tata McGraw Hill.
7. *Oxford Guide to Effective Writing & Speaking by John Seely, Oxford University Press*
8. British Council LearnEnglish Teens Website https://learnenglishteens.britishcouncil.org/

Signature of the BOS Chairman/Languages and Communication

Dr. Arokia Lawrence Vijay, M.A.,M.Phil.,Ph.D.,
Assistant Professor III & Head
Department of Languages and Communication
Kumaraguru College of Technology
[illegible], Tamil Nadu, India.

U18MEI1201	ENGINEERING GRAPHICS	L	T	P	J	C
	(Common to AE, AUE, CE, MCE, ME, EIE and EEE)	2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1:	Construct various plane curves.
CO2:	Construct projection of points and projection of lines.
CO3:	Develop projection of surfaces and solids.
CO4:	Solve problems in sections of solids and development of surfaces.
CO5:	Apply free hand sketching and concepts of isometric in engineering practice.
CO6:	Draw engineering drawing in AutoCAD with dimensions.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M												
CO2	S	S									W			
CO3	S	S									M			
CO4	S	S												
CO5	S	S												
CO6	S													

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment I 2. Continuous Assessment II 3. Assignment 4.End semester	

PLANE CURVES, PROJECTION OF POINTS, LINES AND PLANES	**10 Hours**

Importance of graphics in design process, visualization, communication, documentation and drafting tools, Construction of curves - ellipse, parabola, and hyperbola by eccentricity method only. Orthographic projection of points. Projections of straight lines located in first quadrant - determination of true length and true inclinations. Projections of plane surfaces - polygonal lamina and circular lamina,

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located in first quadrant and inclined to one reference plane.

PROJECTION AND SECTION OF SOLIDS	**10 Hours**

Projection of simple solids - prism, pyramid, cylinder and cone. Drawing views when the axis of the solid is inclined to one reference plane. Sectioning of simple solids - prisms, pyramids, cylinder and cone. Obtaining sectional views and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

DEVELOPMENT OF SURFACES, ISOMETRIC PROJECTIONS AND FREE-HAND SKETCHING	**10 Hours**

Development of lateral surfaces of truncated prisms, pyramids, cylinders and cones.Isometricprojection,Isometricscale,Isometricviewsofsimplesolids,truncatedprisms,pyramid s, cylinders and cones. Free hand sketching techniques, sketching of orthographic views from given pictorial views of objects, including free-hand dimensioning.

PRACTICALS INTRODUCTION TO AUTOCAD	**15 Hours**

Introduction to Drafting Software (AutoCAD) & its Basic Commands. Introduction to coordinate systems, object selection methods, selection of units and precession. sketching – line, circle, arc, polygon, rectangle and ellipse. Working with object snaps, layers and object properties. Editing theobjects–copy,move,trim,extend,workingwitharrays,mirror,scale,hatch,filletandchamfer.

ISOMETRIC VIEWS WITH AUTOCAD	**15 Hours**

Building drawings – Single and double bed room house (sectional Top view only). Introduction to Motion path animation. Isometric views of simple solid blocks.

Theory:30	**Tutorial: 0**	**Practical:30**	**Project:0**	**Total : 60Hours**

REFERENCES:

1. Basant Agrawal and CM Agrawal, Engineering Drawing, McGraw-Hill, New Delhi, First Edition, 2008.
2. Venugopal K. and Prabhu Raja V., Engineering Graphics, New Age International (P) Limited, New Delhi,2008.
3. Natarajan K.V., Engineering Drawing and Graphics, Dhanalakshmi Publisher, Chennai,2005.
4. Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hallof India Pvt. Ltd., New Delhi, Eleventh Edition,2005.
5. Gopalakrishna K.R., Engineering Drawing (Vol. I & II), Subhas Publications,2001.
6. James Leach, AutoCAD 2017 Instructor, SDC Publications,2016.

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U18CSI1202	PROBLEM SOLVING AND PROGRAMMING USING C	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1:	Acquire knowledge on different problem-solving techniques.
CO2:	Use appropriate data types and control structures for solving a given problem.
CO3:	Execute different array and string operations.
CO4:	Experiment with the usage of pointers and functions.
CO5:	Organize data using structures and unions.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M							W					
CO2	S	M							W	W				
CO3	S	W			W	W			W	W		W		
CO4	M	W	M	W	W	W			W	W		M		
CO5	M	W	M	W	W	W			W	W		M		

Course Assessment methods:

DIRECT	INDIRECT

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1. Continuous Assessment Test I, II (Theory Component) 2. Assignment (Theory Component) 3. Group Presentation (Theory Component) 4. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component) 5. Model examination (lab component) 6. End Semester Examination (Theory and lab component)	1.Course-end survey

STRUCTURED PROGRAMMING	**6 Hours**
Algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration). Introduction to C Programming – Operators and Expressions – Data Input and Output – Control Statements	
ARRAYS AND STRINGS	**6 Hours**
Defining an array – Processing an array –Multidimensional Arrays Character Arithmetic – Defining a string – Initialization of Strings – Reading and Writing Strings – Processing Strings –Searching and Sorting of Strings	
FUNCTIONS, STORAGE CLASSES	**6 Hours**
Defining a function–Accessing a function–Function prototypes–Passing arguments to a function–Passing functions – Function with string - Recursion – Storage classes	
POINTERS	**7 Hours**
Pointer Fundamentals – Pointer Declaration – Passing Pointers to a Function – Pointers and one-dimensional arrays – operations on pointers– Dynamic memory allocation.	
STRUCTURES AND UNIONS	**5 Hours**
Structures and Unions: Defining a Structure – Processing a Structure – User defined data types (Typedef) – Unions	
Theory: 30 **Tutorial: 0** **Practical: 0** **Project: 0**	**Total:30 Hours**

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REFERENCES:

1. ByronSGottfriedandJitendarKumarChhabra,"ProgrammingwithC",TataMcGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. Pradip Dey and Manas Ghosh, "Programming in C", Second Edition, Oxford University Press, 2011.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education,2006
4. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.
5. Reema Thareja, "Programming in C", Second Edition, Oxford University Press, 2011.

LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS	**30 Hours**

1. Writing algorithms, flowcharts and pseudo codes for simple problems.
2. Programs on expressions and conversions
3. Programs using if, if-else, switch and nested if statements
4. Programs using while, do-while, for loops
5. Programs on one dimensional arrays, passing arrays to functions and array operations
6. Programs using two dimensional arrays, passing 2D arrays to functions
7. Programs using String functions
8. Programs using function calls, recursion, call by value
9. Programs on pointer operators, call by reference, pointers with arrays
10. Programs using structures and unions.

Theory: 0 Tutorial: 0 Practical:30 Project: 0 Total: 30Hours

REFERENCES

1. Byron S Gottfried and Jitender Kumar Chhabra, "Programming with C", Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. Pradip Dey and Manas Ghosh, "Programming in C", Second Edition ,Oxford University Press, 2011.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education,2006
4. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.

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U18INI1600	ENGINEERING CLINIC I	L	T	P	J	C
		0	0	4	2	3

Course Objectives

- To help the students look into the functioning of simple to complex devices and systems.
- To enable the students to design and build simple systems on their own.
- To help experiment with innovative ideas in design and teamwork.
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Identify a practical problem and find a solution
CO2:	Understand the project management techniques
CO3:	Demonstrate their technical report writing and presentation skills

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

DIRECT	INDIRECT
1. Project reviews50% 2. Workbook report10% 3. Demonstration & Viva-voce40%	1. Course Exit Survey

CONTENT:

The course will offer the students an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building arrange of products.
from toys to robots and flying machines. In the First semester, students will focus primarily on IOT with C programming using Arduino.

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GUIDELINES:	
1. Practical based learning carrying credits. 2. Multi-disciplinary/ multi-focus group of 5-6 students. 3. Groups can select to work on a specific task, or projects related to real world problems. 4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students. 5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester. 6. The progress of the course is evaluated based on reviews and final demonstration of prototype.	
	Total 90 Hours

U18TLR1001	HERITAGE OF TAMILS	L	T	P	J	C
		1	0	0	0	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Enhance the fundamental knowledge of Tamil language and literature

CO2: Understand the heritage, rock art paintings to modern art sculpture

CO3: Acquire essential knowledge in the folk and martial arts

CO4: Understand the importance of role thinai concept of Tamils.

CO5: Gain the knowledge of contribution by tamils to Indian national movement and indian culture

Pre-requisite -

Course Assessment methods:

Direct	Indirect
Final Examination Assignment	Weekly Feedback Survey

UNIT I LANGUAGE AND LITERATURE — **4 Hours**

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 Nayan mars - Forms of minor Poetry -Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE — **4 Hours**

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 - Mridangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS — **4 Hours**

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 Hours**

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 Citiesand Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

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.

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TOTAL: 15 PERIODS
REFERENCES:
1. Social Life of the Tamils - The Classical Period (Dr.S. Singaravelu) (Published by: InternationalInstitute of Tamil Studies.
2. Historical Heritage of the Tamils (Dr.S.V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
3. The Contributions of the Tamils to Indian Culture (Dr.M. Valarmathi) (Published by: International Institute of Tamil Studies.).
4. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Textbook and Educational Services Corporation, Tamil Nadu).
5. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K. Pillay) (Publishedby: The Author).
6. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Textbook and Educational Services Corporation, Tamil Nadu).
7. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

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SEMESTER II

U18MAI2201	ADVANCED CALCULUS AND LAPLACE TRANSFORMS (Common to All branches)	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Evaluate double and triple integrals in Cartesian coordinates and apply them to calculate area and volume.
CO2:	Apply various integral theorems for solving engineering problems involving cubes and rectangular parallelepipeds.
CO3:	Construct analytic functions of complex variables and transform functions from z-plane to w-plane and vice-versa, using conformal mappings.
CO4:	Apply the techniques of complex integration to evaluate real and complex integrals over suitable. closed paths or contours.
CO5:	Determine solution of linear differential equations using Laplace transform technique.
CO6:	Determine multiple integrals, vector differentials, vector integrals and Laplace transforms using. MATLAB.

Pre-requisite: Nil

CO/PO MAPPING

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	PROGRAMME OUTCOMES (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M												
CO2	S													
CO3	M	W												
CO4	W													
CO5	S	M												
CO6	M				M							S		

Course Assessment methods:

DIRECT
1. Continuous Assessment Test I, II (Theory component) Open book test; Cooperative learning report, Assignment, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc (as applicable) (Theory component) 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component) 4. Model examination (lab component) 5. End Semester Examination (Theory and lab component)
INDIRECT

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1. Course-end survey

THEORY COMPONENT

MULTIPLE INTEGRALS **9 Hours**

Double integration in Cartesian coordinates – Change of order of integration - Triple integration in Cartesian coordinates – Applications: Area as double integral and Volume as triple integral.

VECTOR CALCULUS **9 Hours**

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proofs) – Verification of theorem and simple applications.

ANALYTIC FUNCTIONS **9 Hours**

Functions of a complex variable – Analytic functions – Necessary and sufficient conditions in Cartesian coordinates, Cauchy- Riemann equations (excluding proofs)– Properties of analytic function – Construction of analytic function by Milne Thomson method – Conformal mapping : $w = z + c$, cz , $1/z$ – Bilinear Transformation.

COMPLEX INTEGRATION **9 Hours**

Cauchy's integral theorem – Cauchy's integral formula –Taylor's and Laurent's series –Singularities – Residues –Residue theorem –Application of residue theorem for evaluation of real integrals – Contour Integration (excluding poles on the real axis).

LAPLACE TRANSFORMS **9 Hours**

Definition - Properties: Superposition, Shift in t or Time Delay, Shift in s, Time Derivatives, Time Integral- Initial Value Theorem - Final Value Theorem - Transform of periodic functions - Inverse transforms - Convolution theorem – Applications: Solution of linear ordinary differential equations of second order with constant coefficients.

TEXT BOOKS

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2014.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Kreyzig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, 2011.

REFERENCES

1. Veerarajan T., "Engineering Mathematics (for First Year)", Tata McGraw Hill Pub. Co. Ltd., New Delhi, Third Edition, 2011.
2. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2014.
3. Venkataraman M.K., "Engineering Mathematics", The National Publising Co., Chennai, 2003.
4. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.

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LAB COMPONENT **30 Hours**

List of MATLAB Programs :

1. Evaluating double integral with constant and variable limits.
2. Area as double integral
3. Evaluating triple integral with constant and variable limits
4. Volume as triple integral
5. Evaluating gradient, divergence and curl
6. Evaluating line integrals and work done
7. Verifying Green's theorem in the plane
8. Evaluating Laplace transforms and inverse Laplace transforms of functions including impulse.
9. Heaviside functions and problems based on convolution theorem .
10. Applying the technique of Laplace transform to solve differential equations.

Theory: 45 **Tutorial: 0** **Practical: 30** **Project: 0** **Total: 75 Hours**

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U18PHI2202	ENGINEERING PHYSICS (Common to AU, ECE, CE, MEC, ME)	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Enhance the fundamental knowledge in properties of matter and its real timeapplications relevant to various streams of Engineering and Technology
CO2: Understand the phenomenon of heat and its transfer mechanism in engineering systems.
CO3: Acquire essential knowledge in the concepts of quantum mechanics and itsimpact on electron microscopy.
CO4: Analyse the concept of lasers, optical fibers, and their importance in diverse fields of engineering
CO5: Apply the principles of acoustic and ultrasonic techniques for engineering practice
CO6: Gain practical knowledge about the use of physics principles in a right way toimplement modern technology.

Pre-requisites:

High School Education

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S										M
CO2	S	M	M									S
CO3	S	M										
CO4	S	S	M	M								S
CO5	S			M								M
CO6	M	S							M			S

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Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory component)
2. Video presentation, Group activities, Project report, E-Poster preparation,
3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component)
4. Model examination (Lab component)
5. End Semester Examination (Theory and Lab component)
Indirect
1. Course-end survey

Theory Component content:

PROPERTIES OF MATTER	**9 Hours**
Hooke's Law - Elastic moduli - Relation between elastic constants - Poisson's Ratio – Stress - Strain Diagram and its uses – factors affecting elastic modulus – Bending of beams –Expression for bending moment and depression - Cantilever - Depression of a cantilever - experimental determination of Young's modulus by Non uniform bending – I shape girders.	

THERMAL PHYSICS	**9 Hours**
Transfer of heat energy – conduction, convection and radiation – thermal expansion of solids and liquids – expansion joints – bimetallic strips – theory of heat conduction in solids – rectilinear flow of heat – determination of thermal conductivity of a bad conductor - Lee's & Charlton's disc method - Thermal Insulation – classification and properties – heat exchangers -applications – domestic refrigerator – microwave oven.	

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MODERN PHYSICS	9 Hours

Planck's concept (hypothesis) - Compton effect - Expression for Compton shift (Theory and Experiment) - Concept of matter waves - Physical significance of wave function - Schrödinger's wave equation - Time independent and time dependent equation - Eigen values and Eigen function - Particle in a box (one dimension) - Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM).

APPLIED OPTICS	9 Hours

LASERS: Absorption and emission - Spontaneous emission - Stimulated emission - Population inversion - Sources of excitation - Active medium - Resonant cavity - Einstein's theory of stimulated emission - Nd-YAG laser - CO_2 laser - Semiconductor lasers - Applications – holography, cutting, welding and drilling.

FIBER OPTICS: Structure of optical fibre - principle and propagation of light in optical fibres -Numerical aperture and acceptance angle - Types of optical fibres (material, refractiveindex, mode) – Applications - fibre optic communication system, fibre endoscope.

ACOUSTICS AND ULTRASONICS	9 Hours

ACOUSTICS: Classification of sound – characteristics of musical sound –loudness –Weber-Fechner law –decibel - Reverberation - Reverberation time - Sabine's formula (Derivation) - Absorption coefficient and its determination - Factors affecting the acoustics of the buildings and their remedies.

ULTRASONICS: Production of ultrasonic waves - Magneto-striction and Piezoelectric methods - Properties - Detection - Thermal and Kundt's tube methods, Determination of velocity of ultrasonic waves in liquids using acoustic grating – application - A, B, C- scan.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

Lab component Contents:

LIST OF EXPERIMENTS

1. Non-uniform bending – Determination of Young's modulus
2. Compound pendulum – Determination of acceleration due to gravity.
3. Spectrometer – Determination of wavelength of mercury source using grating.
4. Air wedge - Determination of thickness of thin sheet
5. Semiconductor laser:
    a. Determination of wavelength of laser
    b. Determination acceptance angle and numerical aperture of an optical fibre.
    c. Determination of particle size
6. Melde's string – Determination of frequency of a tuning fork
7. Determination of band gap of a semiconductor
8. Determination of efficiency of solar cell
9. Determination of thermal conductivity of a bad conductor – Lee's Disc method
10. Determination of magnetic susceptibility of a solid material – B-H curve apparatus.

Experiments for Demonstration:

1. Hall effect
2. Spin coating unit for thin film fabrication.
3. Four probe experiment
4. Ultrasonic interferometer – Determination of velocity of sound and compressibility of aliquid.

Theory: 0	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 30 Hours**

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Textbook:

1. A textbook of Engineering Physics, M N Avadhanulu, P.G. Kshirsagar and TVS ArunMurthy, S. Chand Publications 11th edition, 2018.

2. Concepts of Modern Physics, Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, 7thEdition, Mc-Graw Hill Education, New Delhi, 2017.

3. Engineering Physics, G. Senthil Kumar, VRB Publishers Ltd., Chennai. 2018.

Reference books:

1. Properties of matter, Brij Lal and Subrahmanyam, S. Chand & Co Ltd., New Delhi,2014.
2. Heat Thermodynamics and Statistical Physics, Brij Lal & Subrahmanyam, S. Chand &Co Ltd, New Delhi, 2012.
3. Quantum Mechanics, Satya Prakash, Pragati Prakashan Publishers, 2015.
4. Lasers: Fundamentals and Applications, Springer Science & Business Media, K. Thiagarajan, Ajoy Ghatak, 2010.
5. Introduction to Fiber Optics, K. Thyagarajan, Ajoy Ghatak, Second Edition, SpringerNew York Dordrecht Heidelberg London, 2010.
6. Ultrasonics: Fundamentals, Technology, Applications, Second Editon, Marcel Dekker,New York, 1988.
7. Practical Physics and Electronics, C. C. Ouseph, U. J. Rao, V. Vijayendran S. Viswanathan (Printers & Publishers), Pvt., Ltd. 2009
8. Laboratory Manual of Engineering Physics, Dr. Y. Aparna & Dr. K. Venkateswara Rao, V.G.S Publishers. 2015

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U18MET2003	ENGINEERING MECHANICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Apply the fundamental concepts in determining the effect of forces on a particle.
CO2:	Make use of various principles in the determination of effect of forces in a rigid body.
CO3:	Determine the geometry dependent properties of solids and sections
CO4:	Solve problems in static friction.
CO5:	Identify motion and determine the velocity and acceleration of a particle.
CO6:	Apply the principles of kinetics in solving problems in dynamics.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						M	
CO2	S						W						M	
CO3	S						W						M	
CO4	M						W						M	
CO5	M						W						M	
CO6	M						W						M	

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment 3. End Semester Examination	1.Course-end survey

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THEORY COMPONENT CONTENTS	
STATICS OF PARTICLES	**9 Hours**
Introduction - Laws of Mechanics, Parallelogram and triangular Laws of forces – Coplanar Forces - Resolution and Composition of forces – Free body diagram - Equilibrium of a particle – Lami's theorem – Equilibrium of a particle in space.	
STATICS OF RIGID BODIES	**9 Hours**
Principle of transmissibility – Moment of force about a point – Varignon's theorem – Moment of a couple – Equivalent couple – Moment of force about an axis – Coplanar non-concurrent forces acting on rigid bodies – Resultant and equilibrium – Resolution of a given force into force couple system – Equilibrium in three dimensions – Reactions and supports.	
GEOMETRY DEPENDANT PROPERTIES	**9 Hours**
Centre of gravity, Centre of mass and Centroid – Moment of Inertia of simple and complex areas – Transfer formula – Radius of gyration – Polar moment of inertia – Product of inertia - Mass moment of Inertia of simple solids.	
FRICTION	**9 Hours**
Laws of friction – coefficient of friction – Dry friction – wedge friction – ladder friction – rolling resistance.	
KINEMATICS OF PARTICLES	**3 Hours**
Kinematics – Rectilinear and curvilinear motion – projectile motion	
KINETICS OF PARTICLES	**6 Hours**
Kinetics – Newton's second law – D'Alembert's Principle – Work Energy method – Principle of Impulse momentum – Impact of Elastic Bodies	
Theory: 45 Hours Tutorial: 0 Practical: 0 Project:0 Total:45 Hours	

REFERENCES:

1. Beer F P and Johnson E R, "Vector Mechanics for Engineers, Statics and Dynamics", TataMc-Graw Hill Publishing Co. Ltd., New Delhi, 2006.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics (Volume II), 7th edition, Wiley student edition, 2013.
4. P. Boresi& J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
5. Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.
6. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi,2006

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U18CSI2201	PYTHON PROGRAMMING (Common to All Branches)	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Classify and make use of python programming elements to solve and debug simple. logical problems. (K4, S3)	K4
CO2:	Experiment with the various control statements in Python. (K3, S2)	K3
CO3:	Develop Python programs using functions and strings. (K3,S2)	K3
CO4:	Analyze a problem and use appropriate data structures to solve it. (K4, S3)	K4
CO5:	Develop python programs to implement various file operations and exception. handling. (K3, S2)	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		S			M					M		M		
CO2			M							M		M		
CO3			M							M		M	M	
CO4	S	S	M		M					M		M	M	
CO5			M							M		M		

Course Assessment methods:

DIRECT	INDIRECT

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1. Continuous Assessment Test I, II (Theory component) 2. Open Book Test, Assignment 3. Viva, Experimental Report for each Experiment (lab Component) 4. Model Examination (lab component) 5. End Semester Examination (Theory and lab components)	1.Course-end survey

THEORY COMPONENT CONTENTS	
BASICS OF PYTHON PROGRAMMING	**6 Hours**
Introduction-Python Interpreter-Interactive and script mode -Values and types, operators, expressions, statements, precedence of operators, Multiple assignments, comments.	
CONTROL STATEMENTS AND FUNCTIONS IN PYTHON	**6 Hours**
Conditional (if), alternative (if-else), chained conditional (if-elif-else)-Iteration-while, for, break, continue, pass – Functions - Introduction, inbuilt functions, user defined functions, passing parameters, return values, recursion, Lambda functions.	
DATA STRUCTURES: STRINGS, LISTS and SETS	**7 Hours**
Strings-String slices, immutability, string methods and operations -Lists-creating lists, list operations, list methods, mutability, aliasing, cloning lists, list and strings, list and functions-list processing-list comprehension, searching and sorting, Sets-creating sets, set operations.	
DATA STRUCTURES: TUPLES, DICTIONARIES	**5 Hours**
Tuples-Tuple assignment, Operations on Tuples, lists and tuples, Tuple as return value-Dictionaries-operations and methods, Nested Dictionaries.	
FILES, MODULES, PACKAGES	**6 Hours**
Files and Exception-Text files, reading and writing files, format Operator-Modules-Python Modules-Creating own Python Modules-packages, Introduction to exception handling.	
Theory: 30 Tutorial: 0 Practical:0 Project: Total: 30Hours	
REFERENCES:	

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1. Ashok Namdev Kamthane, Amit Ashok Kamthane, "Programming and Problem Solving with Python", Mc-Graw HillEducation,2018.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", Second edition, Updated for Python 3, Shroff / O'Reilly Publishers,2016.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd.,2016.
4. Timothy A. Budd," Exploring Python", Mc-Graw Hill Education (India) Private Ltd.,2015.
5. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning,2012.
6. Charles Diesbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition,2013.

E BOOKS AND ONLINE LEARNING MATERIALS

1. www.mhhe.com/kamthane/python
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, second edition, Updated for Python 3, Shroff / O'Reilly Publishers, 2016(http://greenteapress.com/wp/think-python/)

LAB COMPONENT CONTENTS

LIST OF EXPERIMENTS	**30 Hours**

1. Implement simple python programs using interactive and script mode.
2. Develop python programs using id () and type()functions
3. Implement range () function in python
4. Implement various control statements in python.
5. Develop python programs to perform various string operations like concatenation, slicing, Indexing.
6. Demonstrate string functions using python.
7. Implement user defined functions using python.
8. Develop python programs to perform operations on list.
9. Implement dictionary and set in python.
10. Develop programs to work with Tuples.
11. Create programs to solve problems using various data structures in python.
12. Implement python program to perform file operations.
13. Implement python programs using modules and packages

Theory: 0 Tutorial: 0 Practical: 30 Project:0 Total: 30Hours

ONLINE COURSES AND VIDEO LECTURES:

http://nptel.ac.in
https://www.edx.org/course/introduction-to-python-fundamentals-1
https://www.edx.org/course/computing-in-python-ii-control-structures-0
https://www.edx.org/course?search_query=Computing+in+Python+III%3A+Data+Structures

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U18INI2600	ENGINEERING CLINIC - II	L	T	P	J	C
		0	0	4	2	3

Course Objectives:

- To help the students look into the functioning of simple to complex devices and systems.
- To enable the students to design and build simple systems on their own.
- To help experiment with innovative ideas in design and teamwork.
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to	
CO1	Identify a practical problem and find a solution
CO2	Understand the project management techniques
CO3	Demonstrate their technical report writing and presentation skills

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

DIRECT	INDIRECT
1. Project reviews50% 2. Workbook report10% 3. Demonstration & Viva-voce40%	1.Course Exit Survey

Content:

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The course will offer the students an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.
In the Second semester, students will focus primarily on Raspberry pi-based controllers with Python programming

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ multi-focus group of 5-6students.
3. Groups can select to work on a specific task, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. Students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18TLR2001	TAMILS AND TECHNOLOGY	L	T	P	J	C
		1	0	0	0	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Enhance the fundamental knowledge of weaving and ceramic Technology

CO2: Understand the heritage ,rock art paintings to modern art sculpture

CO3: Acquire essential knowledge in the folk and martial arts

CO4: Understand the importance of role thinai concept of tamils.

CO5: Gain the knowledge of contribution by tamils to indian national movement and indian culture

Pre-requisite -

Course Assessment methods:

Direct

Continuous Assessment Test I, II2.

Two Assignments

End Semester Examination

UNIT I WEAVING AND CERAMIC TECHNOLOGY

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY

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 otherworship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras duringBritish Period.

UNIT III MANUFACTURING TECHNOLOGY

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

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY

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.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING

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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.
Theory: 15 Hours **Total Hours: 15**
REFERENCES:
1.Social Life of Tamils (Dr.K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Social Life of the Tamils - The Classical Period (Dr.S. Singaravelu) (Published by: InternationalInstitute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr.S.V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M. Valarmathi) (Published by: International Institute of Tamil Studies.)
5. Keeladi - 'Sangam City C civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Textbook and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K. Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Textbook and Educational Services Corporation, Tamil Nadu) 12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

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SEMESTER III

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U18MAT3101	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS (Common to AE/AUE/CE/ME/MCE/EEE)	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Form partial differential equations and solve certain types of partial differential equations	K2
CO2:	Determine the Fourier Series and half range Fourier Series of a function.	K2
CO3:	Solve one dimensional wave equation, one dimensional heat equation in steady state using Fourier series.	K3
CO4:	Apply Fourier series to solve the steady state two-dimensional heat equation in cartesian coordinates.	K2
CO5:	Identify Fourier transform, Fourier sine and cosine transform of certain functions and use Parseval's identity to evaluate integrals.	K3
CO6:	Evaluate Z–transform of sequences and inverse Z–transform of functions and solve difference equations.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M			M				M	M		S	M	M
CO2	S	M		M									W	W
CO3	S	S	S		S				M	M		S	W	W
CO4	S	M	M									M	W	W
CO5	S	M	M		S								W	W
CO6	S	S			S				M	M		S		

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Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. End Semester Examination 3. Assignment	1.Course end survey

PARTIAL DIFFERENTIAL EQUATIONS	**9+3 Hours**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of PDE by variable separable method – Solution of standard types of first order partial differential equations (excluding reducible to standard types) – Lagrange's linear equation – Linear Homogeneous partial differential equations of second and higher order with constant coefficients.	
FOURIER SERIES	**9+3 Hours**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.	
BOUNDARY VALUE PROBLEMS – ONE DIMENSIONAL EQUATIONS	**5+2 Hours**
Classification of second order quasi linear partial differential equations –Solution of one-dimensional wave equation – One dimensional heat equation (excluding insulated ends) – Fourier series solutions in Cartesian coordinates.	
BOUNDARY VALUE PROBLEMS – TWO DIMENSIONAL EQUATIONS	**4+1 Hours**
Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series. solutions in Cartesian coordinates.	
FOURIER TRANSFORM	**9+3Hours**
Statement of Fourier integral theorem – Infinite Fourier transforms – Sine and Cosine Transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.	
Z –TRANSFORM	**9+3 Hours**
Z-transform - Elementary properties – Convolution theorem- Inverse Z – transform (by using partial fractions, residues and convolution theorem) – Solution of difference equations using Z - transform.	
Theory:45Hours **Practical:15Hours** **Total Hours: 60**	

REFERENCES:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition.2014.
2. Veera Rajan. T., "Transforms and Partial Differential Equations", Tata Mc Graw Hill Education Pvt. Ltd., New Delhi, Second reprint,2012.
3. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics Volume III",S.Chand & Company ltd., New Delhi,2006.
4. Ian Sneddon., "Elements of partial differential equations", McGraw – Hill, New Delhi,2003.
5. Arunachalam T., "Engineering Mathematics III", Sri Vignesh Publications, Coimbatore2013.

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U18MCI3201	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Use passive elements and basic theorems to solve electric circuits.	K2
CO2:	Understand the basic principles of semiconductor devices.	K2
CO3:	Use diode to construct regulators, rectifiers, and other applications.	K3
CO4:	Analyze small signal amplifiers and oscillators constructed using transistors.	K2
CO5:	Apply op-amp to construct various applications.	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
CO1	S												M	
CO2	S												M	
CO3	M		S	M									S	S
CO4	S	S		S									M	
CO5	M		S	M									S	S

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. End Semester Examination 3. Assignment	1.Course end survey

CIRCUIT THEORY INTRODUCTION	**9 Hours**
Network Theorems: Kirchhoff's laws – Thevenin's theorem - Norton's theorem - Superposition theorem – Maximum power transfer theorem – Nodal and Mesh Analysis	
THEORY OF SEMICONDUCTOR DEVICES	**9 Hours**
PN junction – diode equation (Derivation not required) – forward and reverse bias – Diode dc and ac resistances – Zener diode–Bipolar Junction Transistor–CE,CB and CC configurations–Biasing of a transistor: fixed bias, self-bias – FET – Common source and drain characteristics of JFET and MOSFET.	

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APPLICATION OF DIODES	**9 Hours**
Half Wave rectifier and Full Wave rectifiers – Filters with Capacitor and Inductors - Clippers and Clampers – Voltage Multipliers – Voltage regulators – Zener, series and shunt types.	
AMPLIFIERS AND OSCILLATORS	**9 Hours**
Common Emitter configuration - h parameter model for low frequencies – Small signal amplifiers -cascading amplifiers, differential amplifier – Oscillators – Barkhausen stability criterion - Hartley oscillators and Colpitts oscillators	
OPERATIONAL AMPLIFIERS	**9 Hours**
Ideal characteristics – Inverting, Non-inverting – summer – Comparator, Integrator, differentiator – Schmitt trigger – R.C. Phase shift oscillator, Wein Bridge Oscillator – Astable multivibrator	
Theory:45 Hours	**Practical:30Hours** **Total Hours: 75**

REFERENCES:

1. Agarwal, Anant,and JeffreyH.Lang.FoundationsofAnalogandDigitalElectronicCircuits.San Mateo, CA: Morgan Kaufmann Publishers, Elsevier, July 2005. ISBN: 9781558607354(Unit: 1, 2, 3, 4, 5)
2. Albert Malvino and BatesJ., Electronic Principles, Tata McGraw-Hill Pub. Company Ltd., 9th Edition, 2020
3. MillmanJ., HalkiasC.C.andSatyabrataJit,ElectronicDevicesandCircuits,TataMcGrawHill, New Delhi, 2nd edition, 2008.
4. Thomas L. Floyd, Electronic Devices, Pearson Education Asia, 10th edition, 2008.
5. WilliamHayt, KemmerlyJ. and Durban S.M., Engineering Circuit Analysis, 9th Edition, Mc Graw Hill Education, 2020.
6. Sudhakar, Shyam Mohan and Palli S., Circuits and Networks: Analysis & Synthesis, Tata McGraw Hill, New Delhi, 5th edition, 2015.
7. SalivahananS., SureshkumarN. And VallavarajA., Electronic Devices and Circuits, Tata Mc Graw Hill publishing company, New Delhi, 4th edition, 2016
8. Roy ChowdhuryD. and Jain ShailB., Linear Integrated Circuits, NewAgeInt.Pub.,4thedition, 2017.

LIST OF EXPERIMENT:

1. Characteristics of PN junction diode and Zener diode using breadboard and MULTISIM.
2. Input and Output characteristics of BJT using breadboard and MULTISIM.
3. Characteristics of JFET using breadboard and MULTISIM
4. Frequency response of CE amplifier using breadboard and MULTISIM
5. Clipper and Clamper using breadboard and MULTISIM.
6. Phase shift and Wein Bridge oscillators using OP-AMP using breadboard and MULTISIM.
7. Astable multivibrator using OP-AMP using breadboard and MULTISIM.
8. Voltage Regulator (Zener diode, Transistor series and shunt) using breadboard and MULTISIM.
9. Half-wave and Full-wave Rectifier with and without filter using breadboard and MULTISIM.
10. Printed Circuit Board design using software for simple circuits.

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U18MCI3202	ELECTRICAL MACHINES	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Describe the construction, principle of operation and performance of DC motors.	K2
CO2:	Elucidate the construction, principle of operation and performance of Induction Machines	K2
CO3:	Summarize the speed control methods of electrical machines	K2
CO4:	Explain the construction, principle of operation and performance of special machines and Permanent magnet machines.	K2
CO5:	Select suitable motor for simple applications	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M										M	
CO2	M												M	
CO3	M												M	
CO4	M		M										M	
CO5											M		M	

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. End Semester Examination 3. Assignment	1.Course end survey

DC MACHINES	**12 Hours**
DC machines: Principle of working -Construction, -Types of DC machines based on construction-Back emf, voltage equations, torque equation-Characteristics of DC motors - Speed control of DC series and Shunt motors -Armature and Field control.	
AC MACHINES	**12 Hours**
Three phase induction motor: Principle of working -construction - Production of RMF - Torque-slip characteristics, torque equation - cogging – crawling - Speed control of three phase induction motor - Voltage Control-Voltage/frequency control-slip power recovery scheme	

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PERMANENT MAGNET MACHINES	6 Hours
PMDC motors: Construction, principle of operation -Permanent magnet and variable reluctance type: Construction, principle of operation. BLDC motors: Construction, principle of operation.	
SPECIAL MACHINES	**6 Hours**
Stepper motors: Construction, principle of operation Servo motors: Types of servo motors -Servo Mechanism-Construction of AC and DC servo Motors	
SELECTION OF A MOTOR	**9 Hours**
Factors influencing the selection of a motor - Motor Application Requirements – Velocity profiles – Current Density – Heat flow in a Motor - Fatigue and Lubrication tests – trends in test automation CASE STUDY: Selection of a motor for an industrial application.	
Theory:45 Hours	**Practical:30Hours** **Total Hours: 75**

REFERENCES:

1. Theraja B.L and Theraja A.K, "A Textbook of Electrical Technology", Volume 2: AC and DC machines, student edition, S. Chand Publications, 23/e , 2013.
2. JANARDANAN, E.G. SPECIAL ELECTRICAL MACHINES. India, PHI Learning, 2014.
3. Nagrath I J and Kothari DP., "Electrical Machines", 5th Edition, Tata McGraw-Hill, New Delhi, 2017.
4. Pillai SK, "A first course on Electric drives", Wiley Eastern Limited, 3rd edition 2012.
5. Stephen Chapman, "Electric Machinery Fundamentals", McGraw-Hill Series in Electrical and Computer Engineering 7th edition, 2020
6. Univ.-Prof. Dr.-Ing., Dr. H.C. Gerhard Henneberger, "Electrical Machines I Basics, Design, Function, Operation", Aachen University, 2002.

LIST OF EXPERIMENT:

1. Study of Two-point starter
2. Study of Three-point starter
3. Load test on DC series motor
4. Load test on DC Shunt motor
5. Speed control of DC shunt motor using Armature Control
6. Speed control of DC shunt motor using Field Control
7. Open circuit characteristics of DC Generator
8. Load Test on Three Phase Squirrel Cage Induction motor
9. Speed control of three phase slip ring induction motor

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U18MCT3103	MECHANICS OF SOLIDS	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Recognize the elastic response of the materials and calculate the stresses and deflection in simple and compound bars	K2
CO2:	Calculate the thermal stresses and the material response due to temperature variations	K2
CO3:	Find the stresses in bi-axial load system and strain energy for different loads	K2
CO4:	Develop the shear force, bending moment diagram and locate maximum values of shear force and bending moments induced in various types of beams.	K2
CO5:	Estimate the slope and deflection of beams under various loading conditions and crippling load for a column with different end conditions.	K3
CO6:	Determine the power transmitting, torque carrying capacities of the circular shafts and required. thickness of the pressure vessel for a given internal pressure.	K2

Pre-requisite

U18MET2001 Engineering Mechanics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M										S	M
CO2	S		M										S	M
CO3	M		M										S	
CO4	M		M										S	W
CO5	S		M										S	W
CO6	S		S										S	M

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

ELASTIC RESPONSE OF MATERIALS	**12 Hours**
Introduction to elastic response – stresses (tensile, compressive, shear & bending) & strength – strain and deformation, stress-strain curve for steel. Stresses and deformation of simple and compound bars under axial loads - Elastic constants and their relations -Thermal stresses and creep.	
BI-AXIAL STRESSES AND STRAIN ENERGY	**12 Hours**
Principal stresses – Introduction, significance, calculation of principal stresses - Mohr's circle to find. principal stresses. Strain energy in gradually applied loads, suddenly applied loads and Impact loads	
STRESSES IN BEAMS	**12 Hours**
Types of beams supports and loads – Cantilever, simply supported and Overhanging beams - Shear force and bending moment diagrams. Stresses in beams – theory of simple bending and its applicability for actual conditions effect of shape of beams on stress induced - Bending stress and flexural strength.	
DEFLECTION OF BEAMS	**12 Hours**
Elastic curve– Evaluation of beam: Double integration method & Macaulay's method. Columns: End conditions, equivalent length – Euler's equation and its limitations – slenderness ratio – Rankine's formula for columns	
TORSION OF CIRCULAR SECTIONS AND DESIGN OF PRESSURE VESSELS	**12 Hours**
Analysis of torsion of circular bars – shear stress distribution – twist and torsional stiffness – Bars of solid and hollow circular sections. Thin cylinders and shells – Hoop stress and longitudinal stresses.	
Theory:45Hours **Practical:30Hours** **TotalHours:75**	
REFERENCES:	
1. Ramamrutham S, "Strength of materials", 14th Edition, Dhanpat Rai Publishing Company, 2014.	
2. Rattan S S, "Strength of materials", 3rd edition, McGraw Hill, 2016.	
3. Ferdinand Beer and Russell Johnston Jr., "Mechanics of materials", 8th edition, Tata McGraw Hill 2020.	
4. Nash, William. Schaum's Outline of Strength of Materials, 6th Edition. United Kingdom, McGraw-Hill Education, 2013.	
5. RC hibbeler, "mechanics of materials", 9th edition, Pearson, 2014.	

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U18MCT3104	FLUID MECHANICS AND THERMAL SCIENCES	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Describe the properties of fluids and its importance in selection of fluid for suitable application.	K2
CO2:	Apply the concept of fluid statics to determine the pressure and forces on plane and curved surfaces.	K2
CO3:	Differentiate the types of flow with its characteristics and also calculate the flow rate by applying concept of fluid kinematics and dynamics.	K2
CO4:	Identify the major and minor losses involved in the fluid flow through pipes.	K2
CO5:	Explain the concept of boundary layer and methods of preventing the boundary layer separation.	K3
CO6:	Summarize the laws of thermodynamics and concept of heat transfer mechanisms in energy. interactions.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M													
CO2	S													W
CO3	S	M												W
CO4	S	S												W
CO5	W													
CO6	M				W									W

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

PROPERTIES OF FLUIDS AND FLUID STATICS	**14 Hours**
Fluid-definition, distinction between solid and fluid-Units and dimensions–Properties of fluids-density, specificweight, specificvolume,specificgravity,temperature,viscosity,compressibility,vapor	

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pressure, capillary and surface tension. Fluid statics: Pascal law - Hydrostatic law - Pressure measurements using Manometers and pressure gauges - Forces on immersed plane and curved surfaces – Buoyancy – Meta-centre - Stability of floating and submerged bodies.	
FLIUD KINEMATICS AND FLUID DYNAMICS	**10 Hours**
Fluid Kinematics – Types of flow - velocity and acceleration - continuity equation. Fluid dynamics - equations of motion - Euler's equation along streamline - Bernoulli's equation – Applications - Venturi meter, Orifice meter, Pitot tube	
FLUID FLOW AND BOUNDARY LAYER CONCEPTS	**12 Hours**
Hagen Poiseuille Equation - Darcy Welsbach equation - Friction factor – Major and minor energy losses - Flow through pipes in series and in parallel. Types of Boundary layer thickness – Boundary layer separation – Methods of preventing the boundary layer separation.	
LAWS OF THERMODYNAMICS	**12 Hours**
Zeroth law of thermodynamics – Measuring temperature, Thermal expansion, absorption of heat by solids and liquids. First law of thermodynamics – First law applied to flow and non-flow process. Second law of thermodynamics – Entropy	
HEAT TRANSFER MECHANISMS	**12 Hours**
Heat transfer mechanisms: Conduction – Fourier's Law, thermal resistance. Convection – Newton's law of cooling. Radiation – Wien's law, Kirchhoff's law, Stefan-Boltzmann law. Heat exchangers – LMTD – NTU – Fins.	
Theory:45 Hours **Tutorials:15Hours** **TotalHours:60**	
REFERENCES:	
1. White FM., "Fluid Mechanics", 6th Edition, Tata McGraw-Hill, New Delhi, 2018.	
2. CengelYA., CimbalaJM., "FluidMechanics",4th Edition, McGraw Hill higher education, 2019.	
3. Modi PN., Seth SM., Hydraulics and Fluid Mechanics Including Hydraulics Machines. India, Amit Publisher and Distributors, 2019.	
4. Bansal RK., "Fluid Mechanics and Hydraulics Machines", 9th edition, Laxmi publications (P) Ltd., New Delhi, 2011.	
5. Ramamirtham S., "Fluid Mechanics and Hydraulics and Fluid Machines", Dhanpat Rai and Sons, Delhi, 2006.	
6. Nag P.K., "Engineering thermodynamics", Tata McGraw hill, 6th edition, 2017.	
7. Rajput R.K., "Heat and Mass transfer", S. Chand and Co Publishing, 2019.	

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U18INI3600	ENGINEERING CLINIC - III	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Identify a practical problem and find a solution.	K2
CO2:	Understand the project management techniques	K2
CO3:	Demonstrate their technical report writing and presentation skills	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

DIRECT	INDIRECT
1. Project reviews 50%	1. Course Exit Survey
2. Workbook report 10%	
3. Demonstration & Viva-voce 40%	

Content:

The course will offer the students an opportunity to gain a basic understanding of computer controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines. In the third semester, students will focus primarily on design project combining concepts. learnt in Engineering clinics I and II

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GUIDELINES:
1. Practical based learning carrying credits.
2. Multi-disciplinary/ multi-focus group of 5-6 students.
3. Groups can select to work on a specific task, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.
7. multi-disciplinary/ multi-focus group of 5-6 students.
Total Hours: 90

SEMESTER IV

U18MAT4101	NUMERICAL METHODS AND PROBABILITY	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Apply various numerical techniques for solving non-linear equations and systems of linear equations.
CO2:	Analyze and apply the knowledge of interpolation and determine the integration and differentiation of the functions by using the numerical data.
CO3:	Predict the dynamic behaviour of the system through solution of ordinary differential equations by using numerical methods.
CO4:	Solve PDE models representing spatial and temporal variations in physical systems through numerical methods
CO5:	Apply the concepts of probability to random variables
CO6:	Construct probabilistic models for observed phenomena through distributions which play an important role in many engineering applications.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S											M	
CO2	S	S											M	
CO3	S	S							M				M	M
CO4	S	S												
CO5	S	S							M					
CO6	S	S												M

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Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Model Examination (For Practical Courses & Embedded Courses) 3. Assignment, Open Book Test, Cooperative Learning Report, Group Presentation, Problem based Learning, Project based Learning, Mini Projects, Project Report, Quiz, Role Play, Self-Explanatory Videos, Prototype or Product Demonstration etc. (as applicable) 4. End Semester Examination	1 Course End Survey 2. Programme Exit Survey 3. Placement/Higher Education Record 4. Feedback (Students, Employers, Parents, Professional Body members, Alumni)

SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	**9+3Hours**
Linear interpolation method – Iteration method – Newton's method – Solution of linear system By Gaussian elimination and Gauss-Jordan Methods-Iterative methods: Gauss Jacobi and Gauss-Seidel methods – Inverse of matrix by Gauss – Jordan method – Eigenvalues of a matrix by Power method.	
INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION	**9+3Hours**
Lagrange's and Newton's divided difference interpolation – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal and Simpson's rules.	
NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	**9+3Hours**
Single step methods: Taylor's series method – Euler and Improved Euler methods for solving first order equations – Fourth order Runge – Kutta method for solving first and second order equations – Multistep. method: Milne's predictor and corrector method.	
BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS	**9+3 Hours**
Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain–Solution of one dimensional heat equation using Bender Schmidt and Crank Nicholson difference schemes –Solution of one dimensional wave equation by explicit scheme.	
PROBABILITY AND RANDOM VARIABLES	**9+3 Hours**
Axioms of probability - Conditional probability – Total probability – Bayes' theorem – Random variable – Distribution function – properties – Probability mass function-Probability density function – moments -Binomial, Poisson and Normal distributions – Properties.	
Theory:45Hours **Tutorials: 15Hours** **Total: 60Hours**	

REFERENCES:

1. Grewal, B.S. and Grewal, J.S., " Numerical methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 7th Edition, Pearson Education Asia, New Delhi, 2007.
3. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 7th Edition, Tata McGraw-Hill, New Delhi, 2016.
4. R.A. Johnson and C.B. Gupta, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.

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5. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, “Probability and Statistics for Engineers and Scientists”, Pearson Education, Asia, 9th edition, 2017.
6. Gupta S.C, and KapurV.K “Fundamentals of Applied Statistics”, Sultan Chand, New Delhi, 4th Edition, 2014.

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U18MCI4201	HYDRAULICS AND PNEUMATICS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Describe the concept of fluid power and different types of fluid power systems.	K2
CO2:	Explain the working principles of different types of hydraulic pumps.	K2
CO3:	Discuss the working principles of different types of hydraulic actuators.	K2
CO4:	Summarize the working principles of compressors and pneumatic components.	K2
CO5:	Design hydraulic and pneumatic circuits for simple applications.	K3
CO6:	Explain the concept of fluid logic control systems, maintenance of fluid power systems.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M													M
CO2	M	M												M
CO3	M													M
CO4	M													M
CO5	S	M			S								M	M
CO6	M													M

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1. Course end survey

FUNDAMENTALS OF FLUID POWER	**6 Hours**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Properties of hydraulic fluids – General types of fluids. Fluid power symbols.

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HYDRAULIC SYSTEM AND COMPONENTS	10 Hours
Pumping theory – Pump classification – Gear pump, Vane Pump, piston pump, construction and working of pumps – pump performance – Variable displacement pumps. Linear hydraulic actuators – Types of hydraulic cylinders–Single acting, Double acting special cylinders like tandem, Rodless, Telescopic-Constructionand application.Cushioningmechanism,Rotaryactuators-Gear,VaneandPistonmotors-SelectionofPumps and actuators.	
HYDRAULIC VALVES, ACCUMULATORS AND CIRCUITS	**10 Hours**
Directional control valve – 3/2-way valve – 4/2, 4/3 way valve – Shuttle valve – check valve. Pressure control valves, Flow control valve – Fixed and adjustable, electrical control solenoid valves. Types of accumulators, Accumulators circuits, Intensifier – Circuit and Application, Speed control circuits, synchronizing circuit and industrial application circuits – copying circuit and press circuit.	
PNEUMATIC SYSTEMS, COMPONENTS AND CIRCUITS	**10 Hours**
Properties of air – Compressors – Filter, Regulator, and Lubricator Unit – Air control valves, Quick exhaust valves and pneumatic actuators. Pneumo hydraulic circuit, Sequential circuit design for simple applications using cascade method, Karnaugh – Veitch Mapping method.	
FLUID LOGIC CONTROL SYSTEMS AND MAINTENANCE	**9Hours**
Hydro Mechanical servo systems, Electro-hydraulic and Electro-pneumatic systems and proportional valves. Fluidic Logic and switching controls - PLC applications in fluid power control, Maintenance - Failure and trouble shooting in fluid power systems.	
Theory:45Hours **Practical: 30Hours** **Total: 75Hours**	
REFERENCES:	
1. Anthony Esposito, “Fluid Power with Applications”, Pearson Education Inc., 7th Edition 2016.	
2. Majumdar S.R., “Pneumatic systems – Principles and maintenance”, Tata McGraw-Hill, 2012.	
3. James A. Sullivan, “Fluid Power: Theory and Applications”, C.H.I.P.S, 4th edition, 2013.	
4. Andrew Parr, “Hydraulics and Pneumatics ", Jaico Publishing House, 2012	
5.Srinivasan R, “Hydraulic and Pneumatic Controls”, McGraw Hill Education,2016.	
LIST OF EXPERIMENTS	

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Pneumatic Experiments

1. Design of simple pneumatic circuit to control the direction and speed of single acting/double acting cylinder using push button DCV/lever operated DCV and flow control valve.
2. Design of Pneumatic circuit using shuttle valve (OR function) and dual pressure valve (AND function).
3. Design of Pneumatic circuit for automatic reciprocation of single pneumatic cylinder using pilot operated DCV and roller operated DCV.
4. Design of Electropneumatic circuit (Relay control) for automatic reciprocation of single pneumatic cylinder using solenoid operated DCV and magnetic sensors.
5. Design of Pneumatic/ Electropneumatic circuit (Relay control) for synchronization of multiple pneumatic cylinders.
6. Design of Pneumatic/ Electropneumatic circuit (Relay control) for sequential operation of multiple pneumatic cylinders.
7. Design of Pneumatic circuit for sequential operation of multiple pneumatic cylinders using Cascade method.
8. Design of Electropneumatic circuit for sequential operation of multiple cylinders using PLC.

Hydraulic Experiments

9. Design of Hydraulic circuit to control the speed and direction of a hydraulic motor.
10. Design of Hydraulic circuit for sequential operation of two hydraulic cylinders using pressure sequence valve.
11. Study of the working of Counterbalance valve, Accumulator, Proportional control valve.

Software Experiments

12. Design and Simulation of hydraulic and pneumatic circuits using Automation Studio software.

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U18MCI4202	SENSORS AND INSTRUMENTATION	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Classify the transducers and instruments based on their working principles, characteristics a nd order of the system.	K2
CO2:	Describe the working principle and characteristics of non-electrical transducers (Displacement, Velocity, Temperature, Radiation Pyrometer, Humidity measurement)	K2
CO3:	Discuss brief about the Non-electrical transducers of another measurements (Force, strain gauge, Vacuum, Light ,Acoustics and Nuclear radiation measurement)	K2
CO4:	Discuss about the construction, working principles and characteristics of bio medical sensors.	K2
CO5:	Brief the signal conditioning parameters used in measurement system.	K2
CO6:	Illustrate the importance of data acquisition system	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S			W									W	
CO2	S			M	M								M	
CO3	S			M	M								M	
CO4	S	M	S	S	M								S	M
CO5	M	M	S	S	M								S	M
CO6	M	M		S	S								S	

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

MEASUREMENT SYSTEMS	9 Hours

Generalized Measurement System – Performance Characteristics: Static and Dynamic Characteristics – Errors in Measurements – statistical Analysis of errors - Calibration and Standards – Generalized Performance of Zero Order, First Order and Second Order Systems – Classifications of Transducers.

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MEASUREMENT OF NON-ELECTRICAL PARAMETERS-1	9Hours

Linear and angular displacement: Resistive, capacitive, inductive types and Optics (encoders), proximity sensors
Velocity measurement: tachometers, tacho generators and resolvers
Temperature measurement: Contact type: Bimetallic, RTD, Thermocouple and Thermistor **Non- Contact type:**
Radiation Pyrometer – Optical Pyrometer
Humidity: Capacitive and resistive and hot and wet bulbs.
Other sensors: Fire, smoke and metal detectors.

MEASUREMENT OF NON-ELECTRICAL PARAMETERS-2	9 Hours

Force measurement: Resistive type strain gauges: Bridge configurations, Temperature compensation, Load cells,
Fiber optic strain gauge- Semiconductor strain gauges- Piezo electric transducers.
Vacuum Measurement: McLeod Gauge, Thermal Conductivity Gauge – Ionization Gauge.
Airflow: Anemometers
Light: UV, IR, Light emitter and detector
Introduction to Acoustics and acoustic sensors: Ultrasonic sensor- Types and working of Microphones and Hydrophones – Sound level meters- nuclear radiation sensors.

MEASUREMENT OF BIO SIGNALS	9 Hours

Basic transducer principal Types – source of bioelectric potentials - electrode – electrolyte interface, electrode potential, resting and action potential – electrodes for their measurement, ECG, EEG.

SIGNAL CONDITIONING AND DATA ACQUISITION	9 Hours

Amplification, Filtering – Level conversion – Linearization - Buffering – Sample and Hold circuit – Quantization –
Multiplexer / Demultiplexer – Analog to Digital converter – Digital to Analog converter- I/P and P/I converter - Instrumentation Amplifier-V/F and F/V converter- Data Acquisition -Data Logging – Data conversion – Introduction to Digital Transmission system.

Theory:45Hours **Practical:30Hours** **Total Hours:75**

REFERENCES:

1. ErnestODoebelin, "MeasurementSystems–ApplicationsandDesign",TataMcGraw-Hill,2012.
2. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi,2010.
3. John Turner and MartynHill, "InstrumentationforEngineersandScientists",OxfordSciencePublications ,2009
4. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12thedition, Dhanpat Rai & Co, New Delhi,2013.

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LIST OF EXPERIMENTS

1. Design and testing of Voltage to frequency converter and frequency to voltage converter.
2. Design and testing of sample and hold circuit.
3. Displacement measurement using potentiometer and LVDT and plotting the characteristic curves and interface with ARDINUO Board
4. Study of Characteristics and calibration of strain gauge and Load Cell
5. Measurement of strain using resistive type strain gauges with temperature compensation and various bridge configurations interface with ARDINUO Board.
6. Temperature measurement using Thermocouple, Thermistor and RTD and comparing the characteristics interface with ARDINUO Board.
7. Comparison of capacitive and resistive type transducer for humidity measurement with their characteristics
8. Measurement of sound using microphones and sound level meter.
9. Measurement of temperature, strain, displacement, acceleration using NI DAQ and RIO cards.
10. Signal conditioning the physical signals using LABVIEW.

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U18MCT4103	DIGITAL ELECTRONICS AND MICROPROCESSOR	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Use number systems, Boolean algebra and explain various digital logic families.	K2
CO2:	Apply basic logic gates to design simple circuits and simplify logic circuits using K- Map	K3
CO3:	Design various combinational and sequential circuits	K3
CO4:	Explain the architecture of 8085 microprocessor	K2
CO5:	Develop assembly language program for 8085 for the given application.	K3
CO6:	Construct interface for memory and I/O devices.	K3

Pre-requisite

U18MCI3201-Electronics devices and circuits

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M												M	
CO2	S	W	S										S	
CO3	M	S	S										M	M
CO4	M												S	M
CO5	M				S								M	S
CO6	M		S		S								M	S

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	. 1.Course end survey

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NUMBER SYSTEMS, DIGITAL LOGIC FAMILIES AND BOOLEAN LOGIC	9 Hours
Introduction to Number systems: Binary, Octal, Hexadecimal, BCD, Gray code, Excess 3 code -Binary arithmetic: 1's complements, 2's complements, and Code conversions -Digital Logic Families: TTL, CMOS, NMOS, ECL- Performance comparison of various logic families- Boolean algebra: Basic Postulates and theorems, switching functions, Canonical forms, Logic gates- Simplification using K-maps and Implementation using logic gates.	
COMBINATIONAL CIRCUITS	**9 Hours**
Problem formulation and design of combinational circuits: adder, subtractor, Parallel adder and Subtractor- Carry look ahead adder- BCD adder, Magnitude Comparator, parity checker Encoder, decoder,Multiplexer/Demultiplexer,codeconverters,Functionrealizationusinggatesandmultiplexers. Implementation of Combinational circuits using Multiplexers and Demultiplexers- Memory: PROMs and PLAs.	
SEQUENTIAL CIRCUITS	**9 Hours**
General model of sequential circuits: Latch, Flip Flops, Level triggering, Edge triggering, Master slave configuration - Realization of one flip flop using other flip flop- Registers-Counters: Binary counters, Modulo–n counter, Decade, Counters, Ring counter and Johnson counter.	
MICROPROCESSOR 8085	**9 Hours**
Organization of 8085: Architecture, Internal Register Organization and Pin Configuration – Instruction Set of 8085 – addressing modes - instruction and machine cycles with states and timing diagram - 8085 assembly language programming	
MEMORY AND I/O INTERFACING	**9 Hours**
Address space partitioning – address map – Address decoding – Designing decoder circuit for the given. address map -I/O Interfacing- Peripheral ICs*: 8255, 8279 and 8251 A. * Emphasis to be given on architecture with simple applications.	
Theory:45Hours Tutorials:15Hours TotalHours:60	

REFERENCES:

1. Morris Mano M. and CilettiM D., "Digital Design", 4th edition, Prentice Hall of India Pvt.Ltd., NewDelhi,2008
2. Donald P Leach, Albert Paul Malvino and Gautam Saha, "Digital Principles and Applications", 8th edition, Tata McGraw Hill Publishing Company Limited, New Delhi, Special Indian Edition, 2014.
3. Salivahanan S. and Arivazhagan S., "Digital Circuits and Design", 5th edition, oxford university press,2018
4. Ramesh Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", 6th edition, Penram International (India),2013.
5. Aditya P Mathur, "Introduction to Microprocessor", 3rd edition, Tata McGraw Hill, New Delhi,2003
6. Floyd, "Digital electronics" Pearson Education India, 2005

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U18MCT4104	THEORY OF MACHINES	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Apply concepts of mechanisms to achieve desired motion transformation	K2
CO2:	Choose appropriate gear train and friction drives for a given application	K3
CO3:	Calculate various forces acting on rigid bodies under static and dynamic conditions	K3
CO4:	Solve balancing problems related to rotating and reciprocating masses.	K2
CO5:	Apply the fundamental concepts of vibrating system to predict the natural frequency and force transmitted	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S												S	M
CO2	M													M
CO3	M		M										M	
CO4	S		W										M	
CO5	S		W										M	

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

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ANALYSIS OF MECHANISMS	**13 Hours**
Basic Elements of Mechanisms – Introduction to kinematic links, pairs, chain, machine and structure, degrees of freedom. Grashoff's law, Kutzback criterion. Kinematic inversions of four-bar and slider crank chain. Classifications of cam and follower, terminologies, follower motion. Velocity and acceleration analysis for Four bar chain and single slider crank mechanism.	
GEAR AND FRICTION DRIVES	**12 Hours**
Gear and Friction drives - Fundamentals of toothed gearing, spur gear terminology. Involute gear tooth profile. Gear meshing, contact ratio. Gear trains, simple compound gear trains and epicyclic gear trains. Belt, Clutch (Including Problems) – Screw and Brake (Concept only).	
FORCE ANALYSIS	**12Hours**
Rigid Body dynamics in general plane motion – Equations of motion. - Static force analysis – D'Alembert's principle –The principle of superposition – Inertia force and Inertia torque – Introduction to Dynamic Analysis in Reciprocating Engines.	
BALANCING	**9 Hours**
Introduction, static and dynamic. Balancing of single mass rotating in single plane. Balancing of several masses rotating in a single plane. Balancing of several masses rotating in different planes. Introduction to Balancing of reciprocating masses, Hammer blow, Swaying couple, Tractive force.	
VIBRATION	**14 Hours**
Types of vibration, frequency of undamped and damped system. Response to periodic forcing - Harmonic Forcing - Forcing caused by unbalance-Support motion - Force transmissibility and amplitude transmissibility - Vibration isolation.	
Theory:45Hours **Tutorials:15Hours** **Total Hours:60**	

REFERENCES:

1. Rattan SS., "Theory of Machines", 5th Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi,2019.
2. R.L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw Hill Publishing Company Ltd.,2017.
3. R.K. Bansal, "Theory of Machines", Lakshmi publications pvt.ltd.,2016
4. Singiresu S. Rao, "Mechanical Vibrations", Pearson,2017.
5. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, 3rd edition,2013.
6. Pennock, G. R., et al. Theory of Machines and Mechanisms. United Kingdom, Oxford University Press, 2017.

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U18INI4600	ENGINEERING CLINIC IV	L	T	P	J	C
		0	0	4	2	3

Course objectives

• To help the students look into the functioning of simple to complex devices and systems
• To enable the students to design and build simple systems on their own
• To help experiment with innovative ideas in design and teamwork
• To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Identify a practical problem and find a solution	K2
CO2:	Understand the project management techniques	K3
CO3:	Demonstrate their technical report writing and presentation skills	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S		
CO2											S			
CO3										S				

Course Assessment methods:

DIRECT	INDIRECT
1. Project reviews50% 2. Workbook report10% 3. Demonstration & Viva-voce40%	1. Course Exit Survey

Content:

Thecoursewillofferthestudentswithanopportunitytogainabasicunderstandingofcomputercontrolled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample

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opportunity to be innovative in designing and building a range of products from toys to robots and flyingmachines.Inthefourthsemester,studentswillfocusprimarilyonreverseengineeringprojectto improve performance of a product

GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ multi-focus group of 5-6 students.
3. Groups can select to work on a specific task, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18CHT4000	Environmental Science and Engineering (Common to All branches)	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Analyze the impact of engineering solutions in a global and societal context.
CO2:	Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems.
CO3:	Highlight the importance of ecosystem and biodiversity.
CO4:	Consider issues of environment and sustainable development in his/her personal and professional undertakings.
CO5:	Paraphrase the importance of conservation of resources.
CO6:	Play an important role in transferring a healthy environment for future generations.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M					S		M					M
CO2						M				M				
CO3							M							
CO4						M	S							
CO5							S							
CO6			W				S					M		

Course Assessment methods:

DIRECT	INDIRECT
1. Internal Test I 2. Internal Test II 3. Assignment 4. End semester	1.Course end survey

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES	**14 Hours**

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies – Timber extraction, mining, dams and their effects on forests and tribal people.

Water resources: Use and overutilization of surface and ground water, conflicts over water, dams– benefits and problems – Water conservation, rainwater harvesting, watershed management. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

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Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern. agriculture, fertilizer-pesticide problems, case studies.
Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, case studies.
Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Wasteland reclamation – Role of an individual in conservation of natural resources.

ECOSYSTEMS AND BIODIVERSITY	**9 Hours**

ECOSYSTEM: Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Food chain, Food web, Energy flow in the ecosystem and Ecological pyramids – Ecological succession – Introduction, types, characteristic features, structureandfunctionofthe(a)Forestecosystem(b)Grasslandecosystem(c)Desertecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
BIODIVERSITY: Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Bio geographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India–Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

ENVIRONMENTAL POLLUTION	**8 Hours**

Definition – Causes, effects and control measures of: (a) Air pollution – Organic and inorganic pollution – cyclone separator, electrostatic precipitator (b) Water pollution (c) Heavy metal pollution (d) Noise pollution (e) Thermal pollution (f) Nuclear hazards – Role of an individual in prevention of pollution – Pollution case studies – Solid waste and hazardous Management: Causes, effects and control measures from factories, small scale and large-scale industries – Waste minimization – Disaster management: floods, earthquake, cyclone and landslides.

SOCIAL ISSUES AND THE ENVIRONMENT	**7 Hours**

From Unsustainable to Sustainable development – Urban problems related to energy – Resettlement and rehabilitation of people; its problems and concerns, case studies – Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act
– Issues involved in enforcement of environmental legislation – Human Rights.

HUMAN POPULATION AND THE ENVIRONMENT	**7 Hours**

Population growth and explosion – Welfare Program – Environment and human health – Communicable disease – Role of Information Technology in Environment and human health – Case studies.

Theory:45Hours	**Practical:0Hours**	**Total Hours:45**

REFERENCES:

1. Spoolman, Scott, Miller, G. Tyler. Environmental Science. United States, Cengage Learning, 2018.
2. Gilbert M. Masters and Wendell P. Ela, 'Introduction to Environmental Engineering and Science', Third Edition, Pearson Education, 2013.
3. Bharucha, Erach. The Biodiversity of India. India, Mapin Pub., 2002.
4. Trivedy, R K, and Goel, P K. An Introduction to Air Pollution. India, BSP Books Pvt. Limited, 2016.
5. Trivedy, R. K. Handbook Of Environmental Laws, Acts, Guidelines, Compliances & Standards, 2

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Vol. Set, 3Rd Ed. India, BS Publications, 2010.
6. Cunningham, W.P. Cooper and T.H.Gorhani, 'Environmental Encyclopedia', Jaico Publication House, Mumbai, 2011.
7. WagerK.D., 'EnvironmentalManagement',W.B.SaundersCo.,Philadelphia,USA,1998ColinR
8. Townsend, Michael Begon and John L. Harper, 'Essentials of Ecology', Third Edition, Blackwell Publishing, 2008.

U18VET4101	UNIVERSAL HUMAN VALUES 2:	L	T	P	J	C

	UNDERSTANDING HARMONY (Common to all UG branches from 2020-2024 batch onwards)	2	1	0	0	3

COURSE OUTCOMES:

After successful completion of this course, the students shall be able to

CO 1:	Develop a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
CO 2:	Understand (or develop clarity) of the harmony in the human being, family, society and nature/existence
CO 3:	Strengthen their self-reflection.
CO 4:	Develop commitment and courage to act.

Pre-requisites: - None. Universal Human Values 1 (Desirable)

CO-PO AND CO-PSO MAPPING:

COURSE ASSESSMENT METHODS:

Direct

1. Assessment by faculty mentor
2. Self-assessment
3. Socially relevant project/Group Activities/Assignments
4. End Semester Examination

Indirect

1.

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO
CO1						M	M	M	S			M	-	-
CO2						S	M		S	S		S	-	-
CO3								M	M		W	S	-	-
CO4								S	M		M	M	-	-

Assessment by peers (Survey form)

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COURSE CONTENTS:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human beings as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of 'I' and harmony in 'I'.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss

with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:

    a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
    b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

COURSE DURATION:

No	MODULE	HOURS
1	Module 1	[7 Theory+ 3 Tutorial] 10 Hrs
2	Module 2	[6 Theory+ 3 Tutorial] 9 Hrs
3	Module 3	[7 Theory+ 3 Tutorial] 10 Hrs
4	Module 4	[5 Theory+ 3 Tutorial] 8 Hrs
5	Module 5	[5 Theory+ 3 Tutorial] 8 Hrs
	Total	**45**

Theory: 30 Hours	**Tutorial:15**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

TEXTBOOK:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3pZ3yA7g_OAQz
15. https://www.youtube.com/channel/UCo8MpJB_aaVwB4LWLAx6AhQ
16. https://www.uhv.org.in/uhv-ii

SEMESTER V

U18MCI5201	INDUSTRIAL ELECTRONICS AND DRIVES	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to	
CO1: Relate the basic semiconductor physics to the properties of real power. semiconductor.	K2
CO2: Describe the concept of operation of AC-DC converters.	K2
CO3: Identify the operating the single phase and three phase inverter circuits	K3
CO4: Describe the various PWM techniques.	K2
CO5: Identify DC equipment with changing DC voltage and choppers for simple. electrical application	K3
CO6: Describe the speed control method in DC-to-DC converter	K2

Pre-requisite

U18MCI3202- Electrical Machines

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (Pos)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	S				M					M			S	
CO2	S												M	
CO3	S				M								M	
CO4	S	S	S										W	
CO5		M	S		M						M		S	
CO6	S				M					M			S	

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1. Course end survey

POWER SEMICONDUCTOR DEVICES	**9 Hours**
Thyristors – Volt-Ampere Characteristics – Switching Characteristics-Power MOSFET – Volt-AmpereCharacteristics–SwitchingCharacteristics-PowerIGBT–Volt-AmpereCharacteristics-– Switching Characteristics	

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AC to DC CONVERTERS	**9 Hours**
Diode Rectifiers – Single phase Bridge – R, RL – Thyristor Converter – Single phase bridge – RL – Three phase fully controlled converter -R-RL Load.	
INVERTERS	**9 Hours**
Single-phase VSI – Half-bridge – Centre tapped inverter – Full bridge inverter -Three-phase VSI – Square-wave–Control of induction motor by voltage source inverter.	
PWM TECHNIQUES	**9 Hours**
PWM Inverter – fundamental concepts of PWM – naturally sampled PWM - PWM analysis by duty cycle variation	
DC- DC CONVERTER	**9 Hours**
DC Chopper - Step Down Converter – Step Up Converter -Buck Boost Converter – Introduction - Fly Back converter-speed control of PMDC motor.	
Theory:45Hrs **Practical:30Hrs** **Total Hours: 75**	
REFERENCES:	
1. Bimbhra P S, "Power Electronics" Tata McGraw Hill, 2012	
2. Rashid M H, "Power Electronics – Circuits Devices and Application", 4th Edition, Prentice Hall International, New Delhi, 2013.	
3. Dubey G K., Doradia S R., Joshi A. and Singh, R.M., "Thyristorised Power Controllers", 2nd Edition, Wiley Eastern Limited, 2010.	
4. Joseph Vithayathil, "Power Electronics – Principle and Applications", Tata McGraw-Hill Inc, New Delhi, 2010.	
5. Bimal K Bose "Modern power electronics and AC Drives" Prentice Hall International, New Delhi, 2001.	
6. D. Grahame Holmes, Thomas A. Lipo "Pulse Width Modulation for Power Converters: Principles and Practice", John Wiley & Sons, 2003.	
LIST OF EXPERIMENTS:	
1. Voltage-Current characteristics of SCR	
2. Voltage-Current characteristics of IGBT/MOSFET	
3. AC-DC uncontrolled converter	
4. AC-DC converter for half wave controlled using phase control method	
5. Speed control of PMDC motor using three phase fully controlled converter	
6. DC Voltage control using DC – DC Converter	
7. Buck – boost converters	
8. Single phase IGBT based PWM inverter	
9. Speed control of three phase induction motor using AC to AC voltage control	
10. Speed control of BLDC/servo motor	

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U18MCI5202	MANUFACTURING TECHNOLOGY	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Select and justify appropriate casting methods.	K2
CO2:	Summarize various bulk deformation processes and the explain the working. machineries.	K2
CO3:	Describe the working principles of machines and various machining processes.	K2
CO4:	Choose a suitable metal joining process for a given application.	K2
CO5:	Perform various lathe and drilling operation for a given drawing.	K2
CO6:	Perform machining operation in special purpose machine.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					M							W	M
CO2	M												W	M
CO3	M												W	M
CO4	M					M							W	M
CO5	M								M	M			W	M
CO6	M								M	M			W	M

Course Assessment methods:

DIRECT	INDIRECT
1. Internal test I 2. Internal test II 3. End semester Examination. 4. Assignment	1.Course end survey

FOUNDRY TECHNOLOGY	**7 Hours**
Pattern and Core making – Melting furnaces: Cupola and Induction furnaces – Special casting processes – Shell, Investment, Die casting – Defects in casting.	
FORMING PROCESSES	**7 Hours**
Hot and Cold Working - Rolling - Introduction – Rolling Mills – Rolling Operations – Forging– Introduction–ForgingOperations–Dropforging-ExtrusionandDrawing-ExtrusionPractice–Hot,	

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Cold, Impact and Hydrostatic extrusion. Drawing Process – Defects and Residual Stresses – Drawing Equipment.

CONVENTIONAL MACHINING PROCESS **8 Hours**

Lathes and Lathe Operations, Drilling and Drilling Machines, Reaming and Reamers, Tapping and Taps – Tool nomenclature, cutting speed, feed. Milling, Shaping and Grinding Machines and operations.

PRINCIPLES & APPLICATIONS OF JOINING PROCESSES **8 Hours**

Gas welding, Basic Arc Welding Processes, Thermit Welding, Ultrasonic Welding, Friction Welding, Resistance Welding and Explosive Welding. Principles and applications of Brazing and Soldering.

Theory: 30 Hours **Practical: 30 Hours** **Total Hours: 60**

REFERENCES:

1. KalpakjianS., "Manufacturing Engineering and Technology",8th edition, Pearson education India, 2020.
2. Hajra Choudhury S K. and Hajra Choudhury A K., "Elements of Workshop Technology", Volume I and II, Media Promoters and Publishers Private Limited, Mumbai,2008.
3. Paul Degarma E, Black J T. and Ronald A Kosher, "Materials and Processes in Manufacturing", 8th edition, Hall of India, 2008.
4. Sharma P C., "A Textbook of Production Technology", S. Chand and Co., Ltd.,2009.

LIST OF EXPERIMENTS

1. Study on measurement (Linear and angular measurements)
2. Step Turning
3. Taper Turning
4. Thread cutting operation.
5. Knurling operation
6. Boring operation
7. Surface Milling operation
8. Gear Cutting operation.
9. Grinding operation (surface, cylindrical and centerless)
10. Shaping operation (Dove tail and slotting operation)

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U18MCI5203	PROGRAMMABLE LOGIC CONTROLLERS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Outline the importance of PLC, DCS, SCADA in industrial automation	K2
CO2:	Describe the architecture of PLCs with the analogy of relay logic components	K2
CO3:	Develop ladder logic program for applications	K3
CO4:	Integrate PLCs with electro-mechanical systems	K3
CO5:	Classify the communication protocols	K2
CO6:	Design SCADA system for industrial applications	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2	M													
CO3	M	M		M	S					S			S	M
CO4	M	M	M		S								M	
CO5	M												M	
CO6	M	M	M	M	S					S			S	S

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

INTRODUCTION	**6 Hours**
Role of automation in industries, Benefits of automation –Introduction to automation tools: Low-cost automation, PLC, DCS, SCADA - Automation strategy evolution.	
PLC HARDWARE MODULES AND PROGRAMMING	**6 Hours**
CPU – processor function – processor operating modes – PLC system memory and application memory – input modules – output modules – module selection – PLC internal operation and signal processing – input and output processing.	
PROGRAMMING OF PLC SYSTEM	**11 Hours**
Introduction to IEC 61131 - System functions – sequence control – ladder logic – programming sequences – limitation of ladder programming – logic instruction sets – standard PLC functions – special function relays – data handling instructions – arithmetic instructions – data manipulation – program subroutines –programming examples.	

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INDUSTRIAL COMMUNICATION PROTOCOLS	**11 Hours**
Definition of protocol, Introduction to Open System Interconnection (OSI) model, Communication standard (RS232, RS485), Modbus (ASCII & RTU), Introduction to third party interface, concept of OPC (Object linking and embedding for Process Control), Foundation Fieldbus (H1&HSC). Comparison of Foundation Fieldbus, Modbus, Device net, Profibus, Industrial Ethernet.	
SCADA SYSTEMS	**11 Hours**
Concept of SCADA systems, Programming techniques for: Creation of pages, Sequencing of pages, creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management, reporting of events and parameters, Comparison of different SCADA packages, Interfacing PLC and SCADA using communication links, Development stages involved for PLC based automation systems, Application. Development using SCADA system.	
Theory:45 Hours **Practical:30Hours** **Total Hours: 75**	

REFERENCES:

1. John W Webb and Ronald A Reis, "Programmable logic controllers: Principles and Applications", 5th Edition, Prentice Hall India, 2002.
2. Michael P Lukas, "Distributed Control systems", Van Nostrand Rein fold Company,1995.
3. Frank D Petruzella, "Programmable Logic Controllers", 5thedition, McGraw-Hill Companies, March 2019.
4. Ian G Warnock, "Programmable Controllers Operation and Application", Prentice Hall International, UK, 1992.
5. Krishna kant, "Computer Based Industrial Control", 2nd revised edition, Prentice Hall of India,2011.

LIST OF EXPERIMENTS

1. Construct a circuit to control a simple process using Relay and Timer module.
2. Design a T-junction traffic light controller using PLC.
3. Design a PLC Program for automating bottle filling systems.
4. Develop a PLC system to control a simple conveyor system.
5. Study of industrial process automation and communication network architecture
6. Develop an HMI design for a simple pump tank system.
7. Develop a simple SCADA application using Dynamos.
8. Develop a SCADA panel to control a PLC based system.
9. Design a PLC ladder logic program to control the Speed of a motor.
10. Design a PLC ladder logic program to control the Position of a servomotor.

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U18MCT5004	CONTROL ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Know the significance to control engineering and the basic construction of control. systems.	**K2**
CO2	Develop mathematical equations for model mechanical, electrical systems and can be able to compute transfer function using block diagram and signal flow graph methods	**K3**
CO3	Analyze the 1st and 2nd order systems in time domain for various test signals and calculate steady state errors and derive generalized error series in the time domain analysis	**K3**
CO4	Analyze the 1st and 2nd order systems in frequency domain using Bode and Polar plots	**K3**
CO5	Calculate the stability of the system using Routh Hurwitz, Nyquist and Root Locus techniques.	**K3**
CO6	Explain about PID control and tuning, time delay responses and also discuss sequence. control in process industry	**K2**

Pre-requisite

U18MAT3101 Partial differential Equations and Transforms

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2	S												M	
CO3	S		M										M	
CO4	S			M										
CO5			M	M										
CO6	S				M									

Course Assessment methods:

Direct	Indirect

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1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

INTRODUCTION	**12Hours**
Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function of elements - Modeling of physical systems - Mechanical systems - Translational and Rotational systems - Electrical networks - Block diagram – Signal flow graph - Mason's gain formula. Transfer function - Transfer function of DC servomotor, AC servomotor.	
TIME DOMAIN ANALYSIS	**12Hours**
Standard Test signals – Time response of second order system - Time domain response Performance criteria - Types of systems - Steady state error constants - Generalized error series.	
FREQUENCY RESPONSE OF SYSTEMS	**12Hours**
Frequency domain specifications - correlation between time and frequency response for second order systems-Bode plots- Polar Plot -Assessment of stability - Gain Margin and phase Margin Assessment – Lead, lag and Lead lag compensation using Bode Plot. **Tutorials**: Bode plot and polar plot using MATLAB.	
STABILITY OF CONTROL SYSTEMS	**12Hours**
Characteristic equation - Routh Hurwitz criterion of stability - Nyquist stability - Nyquist stability criterion-Assessmentofrelativestability–GainandPhaseMargin.RootLocusconcept-RootLocus procedure - Root Locus construction - Root contours- **Tutorials**: Stability analysis of higher order systems using MATLAB	
AUTOMATIC CONTROL	**12Hours**
Introduction to Automatic Control -P-I-D Control - PID Control Tuning - Feed forward Control Ratio Control - Time Delay Systems and Inverse Response Systems using MATLAB tool.	
Theory:60 Hrs Total Hours: 60	

REFERENCES:

1. Nagrath I J. and Gopal M., “Control Systems Engineering", 5th edition, Prentice Hall of India, New Delhi, 2009.
2. Katsuhiko Ogata, “Modern Control Engineering”, 5th edition, Prentice Hall India, 2011.
3. R.C Dorf and R.H. Bishop, “Modern Control systems”, 12th edition, Pearson India, 2014.
4. Curtis D Johnson, “Process control Instrumentation technology”, Prentice Hall India, 2013.
5. Singh S K., “Computer aided process control”, Prentice Hall India, 2004.

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U18MCT5105	DESIGN OF MACHINE ELEMENTS	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Recognize the design process and the factors influencing it and design the simple components for static loading	**K3**
CO2	Apply the basic concepts of design to Estimate the life of the components subjected to varying loads.	**K3**
CO3	Design the circular shafts based on strength and rigidity, keys and couplings for power. transmitting elements	**K3**
CO4	Apply the basics of power transmission to select the belts	**K3**
CO5	Design the welded joints, threaded joints and springs subjected to static and dynamic loads.	**K3**
CO6	Select the rolling contact bearings for static and cyclic loads	**K3**

Pre-requisite

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M		M								M	W
CO2	S				M								M	
CO3	S												M	
CO4	M												W	
CO5	S												M	
CO6	M												W	

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II **2.** Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) **3.** End Semester Examination	1.Course end survey

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DESIGN PROCESS AND DESIGN FOR STATIC LOAD	9 Hours
Machine Design – Design Process – Factors influencing design – Calculation of stresses for various. load combinations - theories of failure – Factor of safety – Design of curved beams – Crane hook and 'C' frame – Design of levers	
DESIGN OF FLUCTUATING LOAD	**8 Hours**
Stress concentration – causes & remedies – fluctuating stresses – fatigue failures – S-N curve – endurance limit – notch sensitivity – endurance strength modifying factors – design for finite and infinite life – cumulative damage in fatigue failure – Soderberg, Gerber, Goodman, Modified Goodman diagrams – Fatigue design of components under combined stresses	
DESIGN OF POWER TRANSMITTING ELEMENTS	**8 Hours**
Shaft design on the basis of strength, torsional rigidity and lateral rigidity and A.S.M.E. code – Design of keys and splines – Design of flange coupling and flexible bushed pin coupling – Belt drives: Selection of Flat belts, V-belts and ribbed belts.	
DESIGN OF JOINTS AND SPRINGS	**10 Hours**
Threaded fasteners – Bolts of uniform strength – Bolts under tension – Eccentrically loaded bolted joints Welded joints – Welding symbols – Stresses in butt and fillet welds, Design of Welded Joints for static loads – Axially loaded unsymmetrical welded joints, Eccentric load in the plane of welds – theory of bonded joints **Design of springs** Types – applications and materials for springs – Stress and deflection equations for helical compressionsprings–Styleofends–Designofhelicalcompressionandtensionsprings–Springsin series and parallel–Introduction to Concentric helical springs, Helical torsion Spring, Multi-leaf springs – Surge in springs	
ROLLING CONTACT AND SLIDING CONTACT BEARINGS	**10 Hours**
Types of rolling contact Bearings – Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent bearing load – Load-life relationship – Selection of rolling contact bearings – Design for cyclic loads and speed – mounting of bearings – Types of failure in rolling contact bearings – causes and remedies.	
Theory:45 Hrs	**Total Hours:45**

REFERENCES:

1. Bhandari V B., "Design of Machine Elements", 5th edition, Tata McGraw Hill Publication Co. Ltd., 2020.
2. Shigley J E. and Mischke C R., "Mechanical Engineering Design", 11th edition, McGraw Hill International, 2020.
3. Prabhu T J, "Fundamentals of Machine Design", Bharat Institute of Science and Technology, 2010.
4. Alfred Hall, Alfred Holowenko, Herman Laughlin and Somani S, "Machine design", Tata McGraw Hill, 2007.

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U18INI5600	ENGINEERING CLINIC - V	L	T	P	J	C
		0	0	4	2	3

Course objectives

- To help the students look into the functioning of simple to complex devices and systems
- To enable the students to design and build simple systems on their own.
- To help experiment with innovative ideas in design and teamwork.
- To create an engaging and challenging environment in the engineering lab

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Identify a practical problem and find a solution
CO2:	Understand the project management techniques
CO3:	Demonstrate their technical report writing and presentation skills

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S	S	M
CO2											S		S	M
CO3										S			S	M

Course Assessment methods:

DIRECT	INDIRECT
1. Project reviews 50% 2. Workbook report10% 3. Demonstration & Viva-voce 40%	1. Course Exit Survey

Content:

The course will offer the students with an opportunity to gain a basic understanding of computer. controlled electronic devices and apply the concepts to design and build simple to complex devices. As a practical project based embedded course, the students will be taught the concepts using a variety of reference material available in the public domain. While the course will start with formal instruction on hardware, programming and applications, the major portion of the course will provide the students with ample opportunity to be innovative in designing and building a range of products from toys to robots and flying machines.

In the fifth semester, students will focus primarily on design project combining concepts learnt in Engineering clinics I and II

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GUIDELINES:

1. Practical based learning carrying credits.
2. Multi-disciplinary/ multi-focus group of 5-6 students.
3. Groups can select to work on a specific task, or projects related to real world problems.
4. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
5. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
6. The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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SEMESTER VI

U18MCI6201	COMPUTER AIDED MANUFACTURING	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Describe the fundamentals of Computer Aided Design.	K2
CO2:	Describe the basic and constructional features of CNC machines.	K2
CO3:	Develop a CNC part programming for the basic turning and milling operation.	K3
CO4:	Explain the importance of group technology and computer aided process plan.	K2
CO5:	Generate CNC part program for a given components.	K3
CO6:	Draft, model and assemble a given dimensional engineering components.	K3

Pre-requisite

1. U17MCT2001 – Manufacturing Technology

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S									W				
CO2	M												W	
CO3	M	M	M		M								M	
CO4	M		W											
CO5	M				S									
CO6	S				S					M			S	

Course Assessment methods:

DIRECT	INDIRECT
1. Internal Test I 2. Internal Test II 3. End semester Examination. 4. Assignment	1.Course end survey

FUNDAMENTALS OF COMPUTER GRAPHICS	**9 Hours**
Product Cycle- Design Process- Sequential and Concurrent Engineering- Computer Aided Design – CAD System Architecture- Computer Graphics – Co-Ordinate Systems- 2D And 3D Transformations- Homogeneous Coordinates – Line Drawing -Clipping- Viewing Transformation	
INTRODUCTION TO CNC	**8 Hours**

History - Classification, Introduction to NC machine - Introduction to Computer Numerical Control, Features of CNC Machines - Different types of CNC machines – Advantages and disadvantages of CNC machines DNC and Adaptive control - Maintenance features of CNC Machines.

COMPONENTS OF CNC MACHINES AND TOOLING	**10 Hours**

Description of CNC components: Structure, Drive Mechanism, gearbox, Main drive, feed drive, Spindle Motors, Axesmotors-Spindlebearing-Slideways–Recirculatingballscrews–Backlashmeasurement and compensation, linear motion guide ways - Tool magazines, ATC, APC, Chip conveyors - Types of measuring systems in CNC machines –Magnetic Sensors for Spindle Orientation. Qualified and pre-set tooling – Principles of location – Principles of clamping – Work holding devices. Retrofitting of Conventional Machine Tools.

CNC PART PROGRAMMING AND MAINTENANCE	**11 Hours**

Part Program Terminology- G and M Codes – Types of interpolation Methods of CNC part programming–Manual part programming: Fixed cycle, canned cycle–Computer Assisted part. programming – APT language – CNC part programming using CAD/CAM-Introduction to Computer Automated Part Programming. Factors influencing selection of CNC Machines - Practical aspects of introducing CNC machines in industries.

Group Technology and CAPP	**7 Hours**

Introduction, part families, part classification and coding systems: OPITZ, PFA, Benefits of group technology. Approaches to Process Planning, Different CAPP system, application and benefits. Flexible Manufacturing System (FMS) – Components – Layout.

Theory:45 Hrs **Practicals:30 Hrs** **Total Hours: 75**

REFERENCES

1. Radhakrishnan P., "Computer Numerical Control Machines", New Central Book Agency, 2013.
2. Groover M P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall, 2007.
3. YoremKoren, "Computer Control of Manufacturing Systems", Pitman, London, 2017.
4. Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing management "Second Edition, Pearson Education, 1999
5. Ibrahim Zeid, Sivasubramanian R, "CAD/CAM: Theory & Practice" 2nd edition, McGraw Hill, Singapore, 2009.

LIST OF EXPERIMENTS:

1.Drafting

2. Modeling

3. Assembly

4.Part Programming - CNC Turning Centre
   i) Step and Taper Turning
   ii) Thread cutting.
   iii) Drilling

5. Part Programming - CNC Milling Centre
   i) Contouring
   ii) Drilling
   iii) Pocketing

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U18MCI6202	ROBOTICS ENGINEERING	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Explain the robotic terminologies for various configurations	K2
CO2:	Select an appropriate gripper for a given application and use a gripper for pick and place. application	K3
CO3:	Calculate the forward kinematics, inverse kinematics and Jacobian for a serial robot	K3
CO4:	Apply Lagrangian and Newton-Euler methods to analyze dynamic characteristics of a robot	K3
CO5:	Describe various robot motion planning algorithm and robot interfaces	K2
CO6:	Explain and practice various programming techniques used in industrial robots	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S – Strong, M – Medium, W –Weak

Cos	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2	S			W					M	M			M	M
CO3	S	M	M		M				M	M			M	M
CO4	S	M	M										M	M
CO5	M													W
CO6					S				M	M			M	M

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

INTRODUCTION	**6 Hours**
Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission - Applications.	
KINEMATICS OF ROBOTS	**9 Hours**
Introduction - Matrix Representation - Homogeneous transformation matrices – Forward and Inverse kinematics Equations: Position and Orientation -Denavit- Hardenberg Representation of forward kinematics equations of robots- Degeneracy and Dexterity.	
DYNAMICS OF ROBOTS	**11 Hours**

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Introduction- Differential motions of a frame – Jacobian – Singularities – Lagrangian and Newton-Euler formulations – Basics of Trajectory Planning.

ROBOT MOTION PLANNING AND ROBOT INTERFACES	**5 Hours**

Robot Motion Planning: Cartesian Space vs Configuration space, Introduction to motion planning algorithms. Robot interfaces: Low level interfaces, IO digital signals, Fieldbuses – Data protocols and connections

END EFFECTORS	**4 Hours**

End effectors and Different types of grippers, vacuum and other methods of gripping - Grippers. force analysis-Gripper Design-Simple problems

ROBOT PROGRAMMING	**10 Hours**

Robot programming: Introduction; On-line programming: Manual input, lead through programming, teach pendant programming; Off-line programming languages – Simulation.
Introduction to Robotic operating System (ROS) – Visualization using RViz, Moving the robot in Gazebo, Manipulation with MoveIt, - Simulation.

Theory:45 Hrs.	**Practical:30Hrs**	**Total Hours:75**

REFERENCES:

1. Saeed B Niku, 'Introduction to Robotics', 2nd edition, Prentice Hall of India,2011.
2. Mikell P Groover, "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
3. Norberto Pires, 'Industrial Robots programming: Building Applications for the Factories of the Future', 1st edition, Springer,2012
4. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill,2003.
5. Spong and Vidhya sagar, "Robot Dynamics and Control", John Wiley and sons,2008.
6. Fu K S, Gonzalez R C, Lee C S G, "Robotics, control, sensing, Vision and Intelligence", McGraw Hill International,1987
7. Steve LaValle, "Planning Algorithms", Cambridge Univ. Press, New York,2006.
8. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India,2005.
9. Anil Mahtani, Luis Sanchez, Enrique Fernandez, Aaron Martinez, 'Effective Robotics Programming with ROS', 3rd Edition, Packt,2016.

LIST OF EXPERIMENT:

1. Study of different type of robotics simulation software
2. Modeling forward and inverse kinematics for robotic arm using Mathematical Software
3. Offline programming of an Industrial robot using a Robotics simulation Software
4. Setup and program a robot with object profile tracking using a Robotics simulation Software
5. Develop a trajectory planning for a robot using a simulation software.
6. Setup and program an Industrial Robot with a pneumatic vacuum gripper for a simple pick and place operation
7. Writing and verifying a Program for point-to-point operations
8. Robot programming and simulation for Shape identification
9. Setup and Program a robot to avoid obstacles
10. Robot Simulation using Robot Operating System (ROS) and Gazebo

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U18MCI6203	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Compare various cores of embedded systems	K2
CO2:	Brief the architecture, instruction set and interrupts of microcontroller	K3
CO3:	Describe the features of ARM Cortex-M4 controller	K2
CO4:	Interface the peripherals of ARM Cortex-M4 controller	K3
CO5:	Develop embedded systems through hardware and software integration	K3
CO6:	Explain the concepts of real time operating systems	K2

Pre-requisite

1. U18MCT4103- Digital Electronics and Microprocessor

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (Pos)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M										M	M
CO2	M		S	M	S								S	S
CO3	W		M										M	M
CO4	M		S		S								S	S
CO5	W	M	S		S								S	S
CO6	S	S	M	M									M	M

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

INTRODUCTION TO EMBEDDED SYSTEMS	**3 Hours**
Embedded system overview and applications, features - Brief introduction to embedded. microcontroller cores: CISC, RISC, ARM and DSP.	
THE MICROCONTROLLER ARCHITECTURE	**9 Hours**
Introduction to 8051 Microcontroller: Architecture, Pin configuration, Memory organization, Input /Output Ports, Counter and Timers, Serial communication and Interrupts, Instruction set,	
INTRODUCTION TO TIVA ARM CORTEX M4	**9 Hours**
Key Features – Functional Block Diagram - Pin Configuration –I/O pin multiplexing, pull. up/down registers, GPIO control, Memory Mapped Peripherals, programming System registers, Watchdog Timer, need of low power for embedded systems, System Clocks and control, Hibernation Module on Tiva, Active vs Standby current consumption. Introduction to Interrupts,	

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Interrupt vector table, interrupt programming.	
PERIPHERALS OF TIVA ARM CORTEX	**9 Hours**
Timer, Basic Timer, Real Time Clock (RTC), Timing generation and measurements, Analog interfacing and data acquisition: ADC, Analog Comparators, DMA, Motion Control Peripherals: PWM Module & Quadrature Encoder Interface (QEI)	
HARDWARE/SOFTWARE INTEGRATION:	**6 Hours**
Host and Target Machines. Getting Embedded Software into Target System: Programmers, Display, Keyboard, Relay, Stepper and DC Motor Interfacing	
REAL TIME OPERATING SYSTEMS	**9 Hours**
Survey of Software Architectures, Tasks and Task States, Tasks and Data, Semaphores and Shared Data, Message Queues, Mailboxes and Pipes, Timer functions, Events, Memory Management and Interrupt Routines in RTOS Environment. Study of embedded product design with real time concepts using RTOS.	
Theory: 45 Hrs Practical: 30 Hrs. Total Hours: 75	
REFERENCES:	
1. Kenneth J Ayala and Dhananjay V Gadre, "The 8051 Microcontroller & Embedded Systems using Assembly and C" Cengage Learning (India edition), 2010	
2. Jonathan W Valvano, "Introduction to Arm Cortex -M Microcontrollers", 2012.	
3. Steve Furber, "ARM System-on-Chip Architecture", Pearson Education, 2009.	
4. David E Simon, "An Embedded Software Primer", Pearson Education Asia, New Delhi, 2009	
5. Rajkamal," Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill, New Delhi, 2017	
6. Mazidi M A, Mazidi J G. and McKinlay R D., "The 8051 Microcontroller & Embedded	
7. systems", 2nd Edition, Pearson, 2011	
8. Shibu K V., "Introduction to Embedded Systems" McGraw Hill, 2016.	
9. Andrew N Sloss, Dominic Symes and Chris Wright, "ARM system developer's guide", Elsevier, 2010.	
List of Experiments	

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8051 Program using Assembly Language

1. Basic programming using 8051 ALP (addition, subtraction, multiplication, division, ascending, descending etc.)
2. 8051 peripheral programming (ADC, DAC,TIMER)
3. Motor control using 8051(DC motor and stepper motor)

Program using Embedded C

1. LED programming
2. Interface with Relay, Buzzer, seven segment display, LCD.
3. Interface and control the speed of a DC Motor.
4. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
5. Interface DAC and generate waveforms.
6. Measure Ambient temperature using LM35 TEMPERATURE SENSOR and ADC

U18INT6000	CONSTITUTION OF INDIA (Mandatory course)	L	T	P	J	C
		2	0	0	0	0

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Gain Knowledge about the Constitutional Law of India
CO2:	Understand the Fundamental Rights and Duties of a citizen
CO3:	Apply the concept of Federal structure of Indian Government
CO4:	Analyze the Amendments and Emergency provisions in the Constitution
CO5:	Develop a holistic approach in their life as a Citizen of India

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						M			W			S		
CO2						S		S				M		
CO3									M	S		W		
CO4								W	M			M		
CO5						M		M				S		
CO6														

Course Assessment methods:

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DIRECT	INDIRECT
1. Group Activity / Quiz/ Debate / Case studies. 2. Class test /Assignment	1. Surveys

THEORY COMPONENT CONTENTS	
MODULE.1: INTRODUCTION TO INDIAN CONSTITUTION	**4 Hours**
Meaning of the constitution law and constitutionalism - Historical perspective of the Constitution - Salient features and characteristics of the Constitution of India	
MODULE.2: FUNDAMENTAL RIGHTS	**8 Hours**
Scheme of the fundamental rights - Right to Equality - Fundamental Right under Article 19 - Scope of the Right to Life and Liberty - Fundamental Duties and its legal status - Directive Principles of State Policy – Its importance and implementation	
MODULE.3: FEDERAL STRUCTURE	**8 Hours**
Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary Form of Government in India - The constitutional powers and status of the President of India	
MODULE.4: AMENDMENT TO CONSTITUTION	**6 Hours**
Amendment of the Constitutional Powers and Procedure - The historical perspectives of the constitutional amendments in India	
MODULE.5: EMERGENCY PROVISIONS	**4 Hours**
National Emergency, President Rule, Financial Emergency Local Self Government – Constitutional Scheme in India	
Theory:30 Tutorial:0 Practical:0 Project:0 Total:30 Hours	

REFERENCES:

1. Constitution of India - Ministry of Law & Justice – PDF format awmin.nic.in/coi/coiason29july08.pdf\
2. Introduction to the Constitution of India by Durgadas Basu
3. The Constitution of India – Google free material - www.constitution.org/cons/india/const.html
4. Parliament of India – PDF formatdownload.nos.org/srsec317newE/317EL11.pdf
5. The Role of the President of India – By Prof. Balkrishna
6. Local Government in India – E Book - Pradeep Sachdeva https://books.google.com/books/.../Local_Government_in_In...

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SEMESTER VII

U18MBT7001	ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Evaluate the economic theories, Cost concepts and pricing policies	K2
CO2:	Analyze the market structures and integration concepts	K2
CO3:	Apply the concepts of national income and understand the functions of banks and concepts of globalization	K2
CO4:	Apply the concepts of financial management for project appraisal and working capital management	K2
CO5:	Understand accounting systems	K2
CO6:	Analyze financial statements using ratio analysis	K2

Pre-requisite

NIL

CO/PO Mapping

(S/M/W indicates strength of correlation) S – Strong, M – Medium, W –Weak

	Programme Outcomes (PO's)													
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		M				M					M		W	
CO2											M		W	
CO3				M		M					M			
CO4											S			
CO5						M					S			
CO6			M		M						S			

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignments 4. End Semester Exam	1.Course End Survey

Course Content:

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ECONOMICS, COST AND PRICING CONCEPTS	9 Hours
Economic theories – Demand analysis – Determinants of demand – Demand forecasting – Supply – Actual Cost and opportunity Cost – Incremental Cost and sunk Cost – Fixed and variable Cost – MarginalCosting– TotalCost–ElementsofCost–Costcurves–Breakevenpointandbreakevenchart – Limitations of break even chart – Interpretation of break-even chart – Contribution – P/V-ratio, profit-volume ratio or relationship – Price fixation – Pricing policies – Pricing methods.	
CONCEPTS ON FIRMS AND MANUFACTURING PRACTICES	**9 Hours**
Firm – Industry – Market – Market structure – Diversification – Vertical integration – Merger. – Horizontal integration.	
NATIONAL INCOME, MONEY AND BANKING, ECONOMIC ENVIRONMENT	**9 Hours**
National income concepts – GNP – NNP – Methods of measuring national income – Inflation. – Deflation – Kinds of money – Value of money – Functions of bank – Types of banks – Economic liberalization – Privatization – Globalization	
CONCEPTS OF FINANCIAL MANAGEMENT	**9 Hours**
Financial management – Scope – Objectives – Time value of money – Methods of appraising project profitability – Sources of finance – Working capital and management of working capital	
ACCOUNTING SYSTEM, STATEMENT AND FINANCIAL ANALYSIS	**9 Hours**
Accounting system – Systems of book-keeping – Journal – Ledger – Trail balance – Financial statements – Ratio analysis – Types of ratios – Significance – Limitations.	
Theory:45hours **Tutorials:0hour** **Total Hours: 45**	

REFERENCES:

1. Prasanna Chandra, “Financial Management (Theory & Practice), “TMH
2. Weston & Brigham, “Essentials of Managerial Finance”
3. Pandey, I. M., “Financial Management”
4. James C. van Horne. Fundamentals of Financial Management
5. Bhaskar S. “Engineering Economics and Financial Accounting”, (2003) Anuradha Agencies, Chennai
6. James C. van Horne Financial Management & Policy
7. Management Accounting & Financial Management
8. M. Y. Khan & P. K. Jain Management Accounting Principles & Practice -P. Saravanavel
9. Ramachandra Aryasri. A., and Ramana Murthy V.V., ”Engineering Economics &Financial Accounting”-Tata McGraw Hill, New Delhi, 2006.
10. Varshney R.L., and Maheshwari K.L.,” Managerial Economics” – Sultan Chand & Sons, New Delhi, 2001
11. Samvelson and Nordhaus,” Economics”-Tata McGraw Hill, New Delhi, 2002

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U18MCT7001	MOBILE ROBOTICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1: Explain different types of mobile robot locomotion	K2
CO2: Apply mobile robot kinematics and constraints	K2
CO3: Choose sensors for the perception of mobile robots.	K2
CO4: Implement robot localization techniques	K3
CO5: Explain planning and navigation in robotics	K2
CO6: Apply obstacle avoidance techniques in mobile robots	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													M
CO2	S	M	M		M									S
CO3	S				M								M	S
CO4	S				M									S
CO5	S												M	S
CO6	S				M								M	S

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment; Group Presentation, Project report, Poster preparation, Prototype or Product. Demonstration etc (as applicable) 3. End Semester Examination	1. Course end survey

LOCOMOTION	**9 Hours**
Introduction to Robotics – key issues in robot locomotion – Types of Locomotion -legged robots – wheeled mobile robots – aerial mobile robots – stability - robot maneuverability – controllability.	
MOBILE ROBOT KINEMATICS	**9 Hours**
Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, simulation of mobile robots	
ROBOT PERCEPTION	**9 Hours**

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Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors, uncertainty in sensing, filtering.

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MOBILE ROBOT LOCALIZATION	9 Hours
Introduction to localization – challenges in localization – localization and navigation – belief representation – map representation – probabilistic map-based localization – Markov localization, Kalman localization.	
PATH PLANNING AND NAVIGATION	**9 Hours**
Introduction to planning and navigation – planning and reacting – path planning algorithms based. on A-star, Dijkstra, Voronoi diagrams – obstacle avoidance techniques	
Theory:45Hours	**Total Hours: 45**
REFERENCES:	
1. Roland Seigwart, IllahReza Nourbakhsh, and Davide Scaramuzza, "Introduction to autonomous mobile robots", Second Edition, MIT Press, 2011.	
2. Howie Choset, Kevin M. Lynch, Seth Hutchinson , George A. Kantor , Wolfram Burgard , LydiaE.Kavraki,SebastianThrun,"PrinciplesofRobotMotion:Theory,Algorithms,and Implementations", A Bradford Book, 2005.	
3. Gregory Dudek and Michael Jenkin, "Computational Principles of Mobile Robotics", Second Edition, Cambridge University Press, 2010.	
4. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.	
5. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006.	

U18MCT7002	IMAGE PROCESSING AND COMPUTER VISION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1: Summarize the fundamentals of digital image processing	K2
CO2: Apply image enhancement techniques in spatial and frequency domain.	K3
CO3: Apply image segmentation and clustering techniques	K3
CO4: Describe 3D vision concepts	K2
CO5: Choose appropriate techniques for different applications	K4

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	W											S	
CO2	M	M	S		S								W	M
CO3	M	M	S		S								W	M
CO4	M	M		S									M	S
CO5	S	S	S	S	S								S	S

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. End semester Examination. 4. Assignment	1.Course end survey

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FUNDAMENTALS OF IMAGE PROCESSING	**7 Hours**
Introduction to Image processing and Computer Vision; Digital image representation; elements of digital image processing systems; Structure of the human eye; a simple image model; brightness adaptation and discrimination; Electromagnetic Spectrum. Image Sensing and Acquisition. Some Basic Relationships Between Pixels.	
IMAGE ENHANCEMENT	**10 Hours**
Basic gray level transformations-histogram equalization- Arithmetic/logic Operations-Basics of spatial filtering-comparison between smoothing and sharpening spatial filters. 2D Fourier transform -Smoothing & sharpening Frequency domain filters (Ideal, Butterworth, Gaussian)	
SEGMENTATION AND CLUSTERING	**10 Hours**
Segmentation – Thresholding, Edge detection and Region growing, watershed, Binary Morphology and grey morphology operations. boundary descriptors–chain codes –Fourier descriptors –region descriptors, moments Clustering: K-means Clustering. Pattern recognition.	
3D VISION GEOMETRY	**9 Hours**
3D vision tasks, Basics of projective geometry, A single perspective camera , Scene reconstruction from multiple views, Two cameras stereopsis, Three cameras and trifocal tensor, 3D model-based vision , 2D view based representations of a 3D scene	
APPLICATIONS	**9 Hours**
Industrial automation and quality inspection, Object detection; Gesture Recognition; Fingerprint recognition, Vision for robot control-Selection of camera based on applications.	
Theory:45Hrs	**Total Hours:45**
REFERENCES:	
1. Rafael C Gonzalez and Richard E Woods, "Digital Image Processing", 6th Indian Reprint, Pearson Education Asia/Addison Wesley publishing company, 2017.	
2. William K Pratt, "Digital Image Processing", 2nd edition, Wiley-Inter Science Publication, 1991.	
3. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Procesing, Analysis, and Machine Vision", Brooks/Cole, Singapore,2008.	
4. Davies E. R., "Computer & Machine Vision", Academic Press, 2012.	
5. Szeliski R., "Computer Vision: Algorithms and Applications", Springer, 2011.	
6. Simon J. D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 2012	
7. Rafael C. Gonzalez, Richard Eugene Woods, Steven L. Eddins Digital Image Processing Using MATLAB Pearson Education India, 2010.	

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U18MCP7701	PROJECT PHASE I	L	T	P	J	C
		0	0	0	6	3

Course Outcomes

After successful completion of this course, the students should be able to
CO1: Design, analyze, realize / simulate a physical system by using the technology they learnt. during the program.
CO2: Integrate various systems into one Mechatronics product.
CO3: Work in a team with confined time duration.
CO4: Disseminate his work both in oral and written format.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S		M	M				S	S	S
CO2	S	S	S	S	S	M	M	M				S	S	S
CO3									S					
CO4										S	S			

Course Assessment methods:

Direct	Indirect
1. Interdisciplinary work 2. Innovation 3. Working model/ simulation result 4. Report with good referencing. 5. End Semester Viva Voice	1.Course end survey

Students in the form of a group, not exceeding 4 members in a group to carry out their main project. It should be a Mechatronics project. However, special considerations can be given for interdisciplinary measurement and computer-based simulation projects. This exception should be recorded and approved by the department committee. Management-related projects will not be allowed. The interdisciplinary projects will carry more weightage.

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SEMESTER VIII

U18MCP8701	PROJECT PHASE II / INTERNSHIP	L	T	P	J	C
		0	0	0	24	12

Course Outcomes

After successful completion of this course, the students should be able to
CO1: Design, analyze, realize / simulate a physical system by using the technology they learnt. during the program.
CO2: Integrate various systems into one Mechatronics product.
CO3: Work in a team with confined time duration.
CO4: Disseminate his work both in oral and written format.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	S	S	S	S	S		M	M				S	S	S
CO2	S	S	S	S	S	M	M	M				S	S	S
CO3									S					
CO4										S	S			

Course Assessment methods:

Direct	Indirect
1. Inter disciplinary work 2. Innovation 3. Working model/ simulation result 4. Report with good referencing. 5. End Semester Viva Voice	1.Course end survey

Students in the form of a group, not exceeding 4 members in a group to carry out their main project. It should be a Mechatronics project. However, special considerations can be given for interdisciplinary measurement and computer-based simulation projects. This exception should be recorded and approved by the department committee. Management related project will not be allowed. The interdisciplinary projects will carry more weightage.

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PROGRAMME ELECTIVES

U18MCE0001	AUTOMOTIVE ELECTRONICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Explain the basics concepts of automobile engines	K2
CO2:	Describe the components of Engine Control system	K2
CO3:	State the working principle of automotive sensors.	K2
CO4:	Describe the principle of vehicle network protocols	K3
CO5:	Explain the working of various comfort system embedded in automobile	K2
CO6:	Describe the working principle of automobile safety systems	K2

Pre-requisite

U18MCI4202 - Sensors and Instrumentation

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						M					W		
CO2	S					W	W	M					M	M
CO3	S	M											W	M
CO4	S	M	M	W		W		W					S	M
CO5	S		M		M	W	M					W		M
CO6	S		M		M	M	M	W				W	S	S

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

INTRODUCTION	**9 Hours**
Automobile physical configuration - Evolution of electronics in automobiles - Operating principles	

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of IC engine – Two stroke – Four stroke - Major engine components – Engine cylinder arrangements –working of simple carburetor- Ignition system – definition of engine performance terms	
ENGINE CONTROL SYSTEM	**9 Hours**
Motivation For Electronic Engine Control - Electronic Engine Control System - Engine Functions and Control - Electronic Fuel Control System- Engine Mapping- Effect of Air/Fuel Ratio, Spark Timing on Performance, Exhaust Gas Recirculation on Performance- Electronic Ignition. Digital Engine Control System - Engine Crank (Start) - Engine Warm-Up - Open-Loop Control - Closed-Loop Control - Hard Acceleration - Deceleration and Idle	
AUTOMOTIVE SENSORS AND COCK PIT ELECTRONICS	**9 Hours**
Role of sensors and actuators in automotive control- construction and working principle of Mass air flow (MAF) rate sensor - Exhaust gas oxygen sensor - Throttle plate angular position sensor - Crankshaft angular position/RPM sensor - Coolant temperature - Intake air temperature sensor - Manifold absolute pressure (MAP) sensor - Differential exhaust gas pressure sensor - Vehicle speed sensors- Introduction to Cockpit Electronics – Visual displays	
VEHICLE NETWORKS	**9 Hours**
Vehicle Tracking System GPS, Vehicle networks CAN, CAN FD, LIN, Flex Ray- I/O Modules – Features- Advantages- Protocol formats – on board diagnostics systems.	
COMFORT AND SAFETY SYSTEMS	**9 Hours**
Traction control system – Cruise control system– electronic control of automatic transmission antilock braking system – electronic suspension system –airbag systems – centralized door locking system – Navigation systems – climate control of cars- Maintenance and charging of batteries.	
Theory: 45 Hrs.	**Total Hours: 45**

REFERENCES:

1. David Crolla, "Encyclopedia of Automotive Engineering", 6th edition, Wiley, 2015
2. Tom Denton, "Automobile Electrical and Electronics Systems", 2nd edition Edward Arnold Publishers, 2017.
3. William B Ribbens, "Understanding Automotive Electronics", 5th edition, Newness Publishing, 2003
4. Robert Bosch GmbH, "BOSCH Automotive Handbook", 9th edition, Bentley publishers, 2014.
5. Barry Hollembeak, "Automotive Electricity, Electronics and Computer Controls", 3rd edition, Delmar Publishers, 2001.
6. Warren M Farnell, "Fuel System and Emission controls", 1st edition Check Chart Publication, 2005.
7. H.H. Braes, "Handbook of Automotive Engineering", Ulrich Seiffert, 1st edition, SAE International, 2005

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U18MCE0002	CONDITION MONITORING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Recognize the types of failures and maintenance strategies	K2
CO2	Illustrate the fundamental principles of machinery vibration	K2
CO3	Explain signal analysis, fundamentals of FFT and signal conditioning	K2
CO4	Explain the vibration and noise-based condition monitoring techniques	K3
CO5	Explain the thermography and wear analysis for condition monitoring	K2
CO6	Identify and explain the appropriate condition monitoring technique for a given application	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2	M													
CO3	S													
CO4		S											S	
CO5	S												S	
CO6	S	M	M										S	M

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

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FAILURES AND PRINCIPLES OF MAINTENANCE	**07 Hours**
System failure and component failure, Types of failure, Causes of failure, Failure investigation principles, Human factors in failure incidents, Maintenance strategies: Preventive Maintenance, Predictive Maintenance, Bathtub Curve, Failure Modes Effects and Criticality Analysis	
FUNDAMENTALS OF MACHINERY VIBRATION	**10 Hours**
Simple harmonic motion and vibration, Vibration and Spring Mass system, Degrees of freedom, Free vibration and Natural frequency, forced vibration and Vibration isolation, Single Degree-of-Freedom Motion, Forced Vibration Response, Base Excitation, Force Transmissibility and Vibration Isolation, Tuned Vibration Absorber, Unbalanced Response, Characteristics of Vibrating Systems, Vibration of Continuous Systems, Mode Shapes and Operational Deflection Shapes	
DIGITAL SIGNAL PROCESSING	**10 Hours**
Classification of Signals, Signal Analysis, Frequency Domain Signal Analysis, Fundamentals of Fast Fourier Transform, Computer-Aided Data Acquisition, Signal Conditioning, Signal Demodulation, Cepstrum Analysis, Illustrative examples: Representation of signals in the frequency domain, Compressor Vibration and Engine Vibration	
VIBRATION AND NOISE MONITORING	**06 Hours**
Principles of Vibration Monitoring, Misalignment Detection, Eccentricity Detection, Cracked Shaft, Bowed and Bent Shaft, Unbalanced Shaft, Looseness, Rub, Bearing Defects, Faults in Fluid Machines, Acoustical Terminology, Noise Sources, Sound Fields, Noise Measurements, Noise Source Identification	
THERMOGRAPHY	**06 Hours**
Thermal Imaging Devices, Use of IR Camera, Industrial Applications of Thermography in Condition Monitoring	
WEAR DEBRIS ANALYSIS	**06 Hours**
Mechanisms of Wear, Detection of Wear Particles, Oil Sampling Technique, Oil Analysis, Limits of Oil Analysis	
Theory:45Hours	**Total Hours:45**
REFERENCES:	**REFERENCES:**
1. Amiya R. Mohanty, "Machinery Condition Monitoring: Principles and Practices", CRC Press, 2015	
2. R.A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring", Springer,2012.	
3. W.T. Becker, R.J.Shipley, "ASM Handbook: Volume 11: Failure Analysis and Prevention", ASM International, 2002.	
4. V.P. Singh, "Mechanical Vibrations", Dhanpat Rai & Co., 2014.	

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U18MCE0003	MICRO ELECTROMECHANICAL SYSTEMS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes	
After successful completion of this course, the students should be able to	
CO1: Explain the evolution of micro and smart system.	K2
CO2: Illustrate about various sensors and actuating system.	K2
CO3: Classify the Micro machining techniques in MEMS.	K2
CO4: Evaluate a proper scaling method.	K2
CO5: Determine packaging techniques in MEMS and smart system.	K2
CO6: Discuss various applications of MEMS.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2	M													
CO3	S													
CO4		S											S	
CO5	S												S	
CO6	S	M	M										S	M

Course Assessment methods:	
Direct	**Indirect**
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1. Course end survey

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INTRODUCTION	**9 Hours**
Overview - Microsystems and microelectronics - definition-MEMS materials-scaling laws scaling in geometry-scalinginrigidbodydynamics-scalinginelectrostaticforces-scalinginelectricity-scaling. in fluid mechanics- scaling in heat transfer.	
MICRO SENSORS AND ACTUATORS	**9 Hours**
Working principle of Microsystems - micro actuation techniques - micro sensors-types–Micro actuators – types – micro pump – micro motors – micro – valves – micro grippers – micro-Accelerometers	
FABRICATION PROCESS	**9 Hours**
Substrates-single crystal silicon wafer formation-Photolithography-Ion Implantation-Diffusion – Oxidation-CVD-Physical vapor deposition-Deposition by epitaxy-etching process.	
MICRO SYSTEM MANUFACTURING	**9 Hours**
Bulk Micro manufacturing- surface micro machining – LIGA – SLIGA - Micro system packaging-materials - die level-device level-system level-packaging techniques - die preparation -surface. bonding -wire bonding - sealing.	
MICRO SYSTEM DESIGN	**9 Hours**
Design considerations-process design-mask layout design- mechanical design-applications of micro systems in automotive industry, bio medical, aerospace and telecommunications	
Theory:45 Hours	**Total Hours:45**

REFERENCES:

1. Tai-Ran Hsu, “MEMS & Microsystems Design and Manufacture”, Tata McGraw-Hill, 2017.
2. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC press, 2005.
3. Julian W Gardner, Vijay K Varadan, Osama O Awadel Karim, “Microsensors MEMS and Smart Devices”, John Wily and sons Ltd., 2001.
4. Fatikow S, Rembold U, “Microsystem Technology and Micro robotics”, Springer-Verlag Berlin Heidelberg, 1997.
5. Francis E H Tay and W O Choong, “Micro fludics and BioMEMS Applications”, Springer, 2002

U18MCE0004	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Express the basic concepts of Artificial Intelligence	K2
CO2	Demonstrate the usage of planning and decision making.	K3
CO3	Interpret the ideas of machine learning by supervised and unsupervised learning methods	K3
CO4	Apply Linear Regression and Logistic Regression machine learning methods.	K3
CO5	Summarize the concepts of Artificial Neural Networks	K2
CO6	Describe various Artificial Neural Networks methodology	K2

Pre-requisite

Data Warehousing and Data Mining

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M		S	S			S	M		M	M	M
CO2	S	M	M							M		M	W	M
CO3	S	S	M		M					M		M	W	M
CO4	S	S	M		M					M		M	W	M
CO5	S	S	M		S	S			S	M		M	S	M
CO6	S	S	M		S	S		W	S	M		M	S	S

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	1.Course end survey

INTRODUCTION TO ARTIFICIAL INTELLIGENCE	**9 Hours**

Defining Artificial Intelligence, Intelligent Agents, Solving Problems by searching-Problem-solving agents-Example problems – Searching for Solutions-Uninformed search strategies – Informed search strategies – Heuristic functions

KNOWLEDGE REPRESENTATION AND PREDICATE LOGIC	**10 Hours**

Knowledge Representation and Mappings, Approaches to knowledge representation
Representing simple facts in logic, Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming, Forward vs backward reasoning. Classical Planning, Making simple. Decisions

IDEA OF MACHINE LEARNING	9 Hours
Idea of Machine learning from data, Supervised Learning: Learning a Class from Examples–Noise–Learning Multiple Classes– Regression–Model Selection and Generalization, Unsupervised learning-Introduction, k-Means Algorithm, Optimization objective, Random Initialization, Choosing number of clusters -Deep learning.	
LINEAR REGRESSION AND LOGISTIC REGRESSION	**9 Hours**
Linear Regression -Model representation for single variable, Single variable Cost Function, Multivariable cost function, Gradient Decent for Linear Regression, Multivariable model representation, Logistic Regression - Classification, Hypothesis Representation, Decision Boundary, Cost function, Advanced Optimization, Classification (One vs All), Problem of Overfitting, Regularization	
APPLICATIONS	**9 Hours**
Applications of AI- Natural Language Processing – Machine Translation – Robot – Gaming. Introduction to Artificial Neural Networks and Convolution Neural networks – Applications Use of Tensor flow.	
Theory: 45	**Total Hours: 45Hours**

REFERENCES:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 3rd Edition, Pearson Education / Prentice Hall of India,2015.
3. Elaine Rich, Kevin Knight, Shivashankar. B. Nair, "Artificial Intelligence", Tata McGraw Hill, Third Edition, 2009
5. Nils J. Nilsson, "Artificial Intelligence: A new Synthesis", Harcourt Asia Pvt. Ltd.,2000.
6. George F. Luger, "Artificial Intelligence-Structures and Strategies for Complex Problem Solving", Pearson Education / PHI,2008
8. David L. Poole, Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010.
9. EthemAlpaydin, "Introduction to Machine Learning", Second Edition, MIT Press,2015
10. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013
11. Stephen Marsland, ―Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
12. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, "Learning from Data", AML Book Publishers, 2012
13. K. P. Murphy, "Machine Learning: A probabilistic perspective", MIT Press, 2012.
14. M. Mohri, A. Rostamizadeh, and A. Talwalkar, "Foundations of Machine Learning", MIT Press, 2012.

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U18MCE0005	DATABASE MANAGEMENT SYSTEMS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Understand the functional components of DBMS and Relational Model.	K2
CO2	Devise queries using SQL to develop database application	K2
CO3	Describe the database design approaches.	K2
CO4	Understand data storage and retrieval techniques.	K2
CO5	Explore concepts for transaction processing, concurrency control and NOSQL.	K2
CO6	Illustrate the concepts of NOSQL	K2

Pre-requisite

NIL

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M					S		M					M
CO2				M	S			M		M	S	M		M
CO3			M				M						M	
CO4			M				S							
CO5	S						S			M				
CO6	S	M	M							M			M	M

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment: Group Presentation 4. End semester exam	1.Course end survey

INTRODUCTION TO DATABASE AND RELATIONAL MODEL	**9Hours**

Introduction: Database applications, Purpose, Accessing and modifying databases, Architecture of DBMS. Relational Databases: Relational model, Database schema, Keys, Formal Relational Query Languages

DATABASE APPLICATION DEVELOPMENT	**9 Hours**

Guidelines for Database Design. SQL: Data definition, Basic SQL query structure, specifying integrity constraints in SQL, set operations, Nested subqueries, Aggregation, Join expressions, Views. Functions, Procedures and Triggers. Accessing Databases from Programs using JDBC, Building Web Applications using PHP &MySQL. Case Study: Open-Source Relational DBMS

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DATABASE DESIGN	**9 Hours**
Database Design: E-R model, E-R diagram, Reduction to relational schema, E-R design issues, Relational Database Design: features of good design, Functional Dependency theory, decomposition using functional dependency, Normal forms. (Optional: multi-valued dependency and 4th normal form).	
STORAGE AND INDEXING	**7 Hours**
Storage and File structure: File Organization, RAID. Indexing: Concepts, Clustered and Non-clustered Indices, B-tree and B+-tree. Basics of Hashing (Static, Dynamic). Overview of Query processing.	
TRANSACTION MANAGEMENT	**11 Hours**
Transactions: Concept and purpose, ACID properties and their necessity, transactions in SQL. Transaction Schedules: Conflicts and Aborts, Serializability, Recoverability. Concurrency Control: lock-based protocols, 2- phase locking, Timestamp based protocols. Deadlock handling. Case Study: NoSQL: CAP Theorem and BASE Properties, Types of NoSQL Systems.	
Theory: 45	**Total Hours: 45Hours**

REFERENCES:

1. Abraham Silberschatz, Henry Korth, and S. Sudarshan, "Database System Concepts", Sixth Edition, McGraw-Hill.2016.
2. R. Elmasri and S. Navathe, "Fundamentals of Database Systems", Sixth Edition, Pearson Education,2016
3. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, 3rd Edition, McGraw Hill,2014.
4. Thomas M. Connolly and Carolyn E. Begg, "Database Systems - A Practical Approach to Design, Implementation and Management", Fifth edition, Pearson Education, 2014
5. C.J. Date, A. Kannan and S.Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.

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U18MCE0006	SOFT COMPUTING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Identify and describe soft computing techniques and their roles in building intelligent. machines	K2
CO2	Recognize the feasibility of applying a soft computing methodology for a particular problem	K2
CO3	Identify and select a suitable classification/clustering algorithm to solve the problem	K2
CO4	Apply evolutionary algorithms and Fuzzy logic to solve the problem	K2
CO5	Discuss the soft computing systems by hybrid soft computing techniques	K2
CO6	Describe the various optimization techniques used in soft computing	K2

Pre-requisite

NIL

	CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	S	M	S										S	S
CO2	S	M											M	
CO3	S		S	S				S	S				M	S
CO4	S		S		S	M		S	S				M	S
CO5	S				S			S						
CO6	S	S						S					W	W

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment: Group Presentation 4. End semester exam	1.Course end survey

INTRODUCTION TO FUZZY SETS AND FUZZY LOGIC SYSTEMS	9 Hours

Fuzzy sets and Fuzzy logic systems- Classical Sets and Fuzzy Sets and Fuzzy relations- Operations on Classical sets, properties of classical sets, Fuzzy set operations, properties of fuzzy sets, cardinality, operations, and properties of fuzzy relations. Membership functions: Features of membership functions, standard forms and boundaries, different fuzzification methods Fuzzy to Crisp conversions: Lambda Cuts for fuzzy sets, fuzzy Relations, Defuzzification methods.

FUZZY RULE BASED SYSTEMS	9 Hours

Classical predicate logic, Fuzzy Logic, Approximate reasoning and Fuzzy Implication- Linguistic Hedges, Fuzzy Rule based system – Aggregation of fuzzy Rules, Fuzzy Inference System- Mamdani Fuzzy Models – Sugano Fuzzy Models. Applications of Fuzzy Logic: How Fuzzy Logic is applied in Home Appliances, General Fuzzy Logic controllers, Basic Medical Diagnostic systems and Weather forecasting

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INTRODUCTION TO NEURAL NETWORKS	**9 Hours**
Advent of Modern Neuroscience, Classical AI and Neural Networks, Biological Neurons and Artificial neural network; model of artificial neurons. Learning Methods: Hebbian, competitive, Boltzmann etc., Neural Network models: Perceptron, Adaline and Madaline networks; single layer network; Back propagation and multi-layer networks. Competitive learning networks: Kohonen self-organizing networks, Hebbian learning; Hopfield Networks.	
GENETIC ALGORITHMS	**9 Hours**
Simple GA, crossover and mutation, Multi-objective Genetic Algorithm (MOGA) Applications of Genetic Algorithm: genetic algorithms in search and optimization, GA based clustering Algorithm, Image processing and pattern Recognition.	
HYBRID SOFT COMPUTING TECHNIQUES	**9 Hours**
Introduction - Neuro-Fuzzy Modelling-Applications of Neural Networks- Pattern Recognition and classification Genetic-Neuro Hybrid System, Genetic-Fuzzy Hybrid System, Fuzzy-Genetic Hybrid System, Simplified Fuzzy ARTMAP, Application of Soft Computing, CASE Study. Other Soft Computing techniques: Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).	
Theory: 45Hrs	**Total Hours: 45 Hrs.**
REFERENCES:	

1. Samir Roy, Udit Chakraborty, ―Introduction to soft computing - neuro-fuzzy and genetic algorithm‖, Person Education, 2013
2. Timothy J. Ross, ―Fuzzy Logic with Engineering applications‖, Tata McGraw Hill New York, Third edition, 2016
3. DavidE.Goldberg, ―GeneticAlgorithmsinSearchOptimizationandMachineLearning‖,PearsonEducation, 2007.
4. J.-S. R Jang., C.-T Sun., & E. Mizutani, ―Neuro-Fuzzy and Soft Computing, A Computational Approach to Learning and Machine Intelligence‖, Prentice-Hall of India Pvt. Ltd., 2005.

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U18MCE0014	UNDER WATER ROBOTICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Express the basic concepts of underwater vehicle and Manipulator Systems	K2
CO2	Describe the rigid body kinematics of Autonomous Underwater vehicle and manipulators	K2
CO3	Summarize the dynamics of Autonomous Underwater vehicle and manipulators.	K2
CO4	Apply controllers for dynamic control of Autonomous Underwater vehicles.	K2
CO5	Discuss the concepts of kinematic control of Underwater manipulator systems.	K2
CO6	Describe various dynamic control theories of Underwater manipulator systems.	K2

Pre-requisite

NIL

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S											W		
CO2	S	M												
CO3	S	M				M							M	S
CO4	S	W		W	M								S	S
CO5	S	M		W	M								W	W
CO6	S	M		W	M								M	M

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment: Group Presentation 4. End semester exam	1.Course end survey

MODELLING OF UNDER WATER ROBOTS	**9 Hours**
Introduction to Underwater Vehicles -Sensorial Systems, Actuation, Localization, Autonomous Underwater Vehicles (AUV) Control Fault Detection/Tolerance for UUVs, Underwater Vehicle Manipulator Systems (UVMS) Coordinated Control, Future Perspectives.	
MODELLING OF UNDER WATER ROBOTS	**10 Hours**
Rigid Body's Kinematics-Attitude Representation by Euler Angles, Attitude Representation by Quaternion, Attitude Error Representation,6-DOFs Kinematics, Rigid Body's Dynamics-Rigid Body's Dynamics in Matrix Form.	

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DYNAMIC CONTROL OF AUVS	**9 Hours**
Earth Fixed Frame Based, Model Based Controller, Earth Fixed Frame Based, Non model Based Controller, Vehicle Fixed Frame-Based, Model-Based Controller, Mixed Earth/Vehicle Fixed Frame Based Controller.	
KINEMATIC CONTROL OF UVMS	**8 Hours**
Earth Fixed Frame Based, Model Based Controller, Earth Fixed Frame Based, Non model Based Controller, Vehicle Fixed Frame-Based, Model-Based Controller, Mixed Earth/Vehicle Fixed Frame Based Controller.	
DYNAMIC CONTROL OF UVMS	**9 Hours**
Feed forward Decoupling Control, Feedback Linearization, Non-regressor-Based Adaptive Control, Sliding Mode Control, Adaptive Control, Output Feedback Control.	
	Total Hours: 45

REFERENCES:

1. Gianluca Antonelli, Underwater Robots: Motion and Force Control of Vehicle-Manipulator Systems, Springer Berlin Heidelberg, Second Edition 2010
2. C. Vasudevan, K. Ganesan, Underwater Robots, Springer, Third Edition, 2015.
3. Frank Kirchner, Sirko Straube, Daniel Kühn, AI Technology for Underwater Robots, First Edition 2019.
4. Steven W. Moore, Harry Bohm, Vickie Jensen, Underwater Robotics: Science, Design & Fabrication, Marine Advanced Technology Education (MATE) Center, 2010.
5. Daniel R. Faust, Underwater Robots, The Rosen Publishing Group, Inc, First Edition, 2016.

U18MCE0007	INDUSTRIAL IOT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Explain the basic principles of smart manufacturing.	K2
CO2	Illustrate the importance of IoT in smart manufacturing	K2
CO3	Describe the functions of internet of things (IoT).	K2
CO4	Explain the key elements of Industrial internet of things (IIoT).	K2
CO5	Explain the functions of big data analytics.	K2
CO6	Discuss various applications of Industrial IoT.	K2

Pre-requisite

NIL

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2	M													
CO3	S													
CO4		S											S	
CO5	S												S	
CO6	S	M	M										S	M

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1. Course end survey

INTRODUCTION	**9 Hours**
Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories	

IoT COMPONENTS	**9 Hours**
Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data And Advanced Analysis, Cyber security inIndustry4.0, Basics of Industrial IoT, Industrial Sensing & Actuation, Industrial Internet Systems.	

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INDUSTRIAL IoT	**9 Hours**
Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, IIoT Reference Architecture, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Communication, IIoT Networking.	
INDUSTRIAL IoT: BIG DATA ANALYTICS	**9 Hours**
IIoT Analytics - Introduction, Machine Learning and Data Science, IoT Platforms, Data Management tool, Software-Defined Networking, Data Center Networks, Cloud Computing	
INDUSTRIAL IoT- APPLICATION	**9 Hours**
Power Plants, Oil, chemical and pharmaceutical industry, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility. Management.	
Theory:45Hours	**Total Hours: 45**

REFERENCES:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.
2. Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing Systems", Springer, 2017.
3. Andrew Minteer, "Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices", Packt Publishing, 2017.
4. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publications, 2013.
5. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, 2011.

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U18MCE0008	STATISTICAL QUALITY CONTROL	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Define the concept of probability and quality control	K2
CO2	Explain various sampling method to measure quality and the attributes of quality.	K2
CO3	Summarize the process behavior based on various control charts for variables.	K2
CO4	Summarize the process behavior based on various control charts for attributes	K2
CO5	Select the appropriate samples for the study.	K2
CO6	Apply various techniques to improve the overall quality.	K2

Pre-requisite

NIL

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S		M					S					
CO2	S			M					S					
CO3	S	M		S										
CO4	S				S	M				S				
CO5														
CO6														

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment: Group Presentation 4. End semester exam	1.Course end survey

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INTRODUCTION	**9 Hours**
Probability concepts, Review of distribution: Normal, Poison's, and Binomial, Problems, Measuring of quality and control, Value and quality, Quality costs, Quality assurance	
CONTROL CHARTS FOR VARIABLES	**9 Hours**
Chance and assignable causes of quality variation, Control charts for variables, X-bar, R, and s-charts, Warning and modified control limits, Process capability study, Ranges, Moving Averages, and Six s-limits, multivariate charts.	
CONTROL CHARTS FOR ATTRIBUTES	**9 Hours**
Limitation of variable chart, p-chart, problems with variable sample size, np-chart, c- chart, u-chart, and ku-chart, Demerits per unit control chart.	
ACCEPTANCE SAMPLING	**9 Hours**
Economics of sampling, Lot formation, OC-Curve-Producer's and Consumer's risk, Single and double sampling plans, AOQ, AOQL, ATI, ASN, Sequential sampling plan, MIL – STD – 1050 tables, MIL – STD – 414 tables, IS 2500 Standard.	
QUALITY IMPROVEMENT	**9 Hours**
Zero defects program, Quality circle, Fishbone diagram, scatter diagram, Pareto Analysis, Deming cycle, Introduction to Reliability function, System reliability of series, parallel, and combined configurations, Reliability improvement techniques.	
Theory: 45Hours	**Total Hours:45**

REFERENCES:

1. Grant E.L. and Leavenworth, "Statistical Quality Control", Tata McGraw-Hill Publishing Company, 5th edition 2002.
2. Douglas C. Montgomery, "Statistical Quality Control", John Wiley and Sons, 2001.
3. Fiegenbaum, A.V., "Total Quality Control", McGraw-Hill Inc., 1991.
4. Sharma S.C., "Inspection Quality Control and Reliability", Khanna Publishers, New Delhi, 2006
5. Srinath L.S "Reliability Engineering", Affiliated East west Press, 2005.

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U18MCE0009	COMPOSITE AND SMART MATERIALS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Recognize the need and characteristics of the composite materials	K2
CO2	Explain the manufacturing processes of composite materials	K2
CO3	Explain the applications of composites and its sustainability	K2
CO4	Explain the principle and working of Piezoelectric and Magnetostricitve materials	K2
CO5	Explain the electro active materials and shape memory alloys	K2
CO6	Understand the concept behind smart composites	K2

Pre-requisite

Nil

CO – PO Mapping

(S/M/W indicates strength of correlation) S – Strong, M – Medium, W - Weak

CO's	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	S													
CO2													M	
CO3							M							
CO4	S												M	
CO5													M	
CO6	M													

Course Assessment Methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

INTRODUCTION TO COMPOSITE MATERIALS	9 Hours
Need and general characteristics of composite materials- mechanical advantages and limitations Characteristics of fibers and matrixes – classification of composites – Prepregs – Lamina, Laminate and sandwich construction. Ceramics.	

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MANUFACTURING AND QUALITY INSPECTION	9 Hours
Fundamentals of curing – Bag molding process – compression and vacuum molding – filament winding – Quality inspection methods for raw materials – cure cycle monitoring – cured composite parts.	
APPLICATIONS OF COMPOSITES AND SUSTAINABILITY	**9 Hours**
Applications of composites - Natural fibers needs and its significance - Recycling of composites	
PIEZOELECTRIC AND MAGNETOSTRICTIVE MATERIALS	**9 Hours**
Introduction to Smart Materials, Principles of Piezoelectricity, Perovskyte Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications. Principles of Magnetostriction, Rare earth Magneto strictive materials, Giant Magnetostriction and Magneto-resistance effect. Magneto strictive Actuation, Joule Effect, Wiedemann Effect, Magneto volume Effect, Magneto strictive Mini Actuators.	
ELECTRO ACTIVE MATERIALS AND SHAPE MEMORY ALLOYS	**9 Hours**
Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rheological Fluids. IPMC and Polymeric Actuators, Shape Memory Actuators. .	
Theory: 45 Hours	**Total: 45 Hours**

References:

1. Mallick P K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", 3rdEdition, Maneel Dekker Inc, 2008.
2. Brian Culshaw, Smart Structures and Materials, Artech House,2000
3. Gauenzi, P., Smart Structures, Wiley,2009
4. Cady, W. G., Piezoelectricity, Dover Publication

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U18MCE0010	ADDITIVE MANUFACTURING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes:

After successful completion of this course, the students should be able to		
CO1	Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.	K2
CO2	Acquire knowledge on process of transforming a concept into the final product in AM. technology.	K2
CO3	Elaborate the vat polymerization and material extrusion processes and its applications.	K2
CO4	Acquire knowledge on powder bed fusion processes and its applications.	K2
CO5	Acquire knowledge on direct energy deposition processes and its applications.	K2
CO6	Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes.	K3

Pre-requisite:

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	S													M
CO2	S		M										M	M
CO3	S		M										M	M
CO4	S		M										M	M
CO5	S		M										M	M
CO6	S		M										M	M

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1.Course end survey

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INTRODUCTION	9 Hours
Overview – Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits. Applications: Building Printing-Bio Printing- Food Printing-Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.	
DESIGN FOR ADDITIVE MANUFACTURING (DFAM)	**9 Hours**
Concepts and Objectives- AM Unique Capabilities: Part Consolidation-Topology Optimization- Lightweight Structure - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation –Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation-Customized Design and Fabrication for Medical Applications- Case Studies.	
VAT POLYMERIZATION AND MATERIAL EXTRUSION	**9 Hours**
Photo polymerization: Stereolithography Apparatus (SLA) - Materials -Process -Advantages- Limitations-Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM) - Process-Materials - Applications and Limitations.	
POWDER BED FUSION AND DIRECT ENERGY DEPOSITION	**9 Hours**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism – Process Parameters – Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS) - Process -Material Delivery - Process Parameters -Materials - Benefits -Applications.	
OTHER ADDITIVE MANUFACTURING PROCESSES	**9 Hours**
Binder Jetting: Three-Dimensional Printing - Materials -Process - Benefits and Limitations. Material Jetting: MultiJet Modeling- Materials- Process- Benefits. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation.	
	Total Hours: 45

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hotter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States,2015,
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015,
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015,
4. AndreasGebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2012,
5. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States, 2011,
6. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A toolbox for prototype development”, CRC Press., United States, 2019,
7. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom,2016,

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U18MCE0011	DESIGN OF MATERIAL HANDLING SYSTEMS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Recognize the need and types of the Material Handling Equipment	K2
CO2	Calculate the power requirements for a given belt conveyor	K3
CO3	Select the components for the belt conveyors	K3
CO4	Select and design the conveyors for the particular application	K3
CO5	Differentiate the conveyors and elevators and design the bucket and cage elevators	K3
CO6	Explain the various elements of the hoists	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	M													
CO2	M													
CO3	M		M										M	
CO4	M	W	S			W							M	W
CO5	M	W	M										M	
CO6	M		M										M	

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable). 3. End Semester Examination	1.Course end survey

MATERIAL HANDLING EQUIPMENTS (MHE)	4 Hours
Materials and Bulk materials – Types of material handling equipment – selection and applications of MHE. Automation in material handling system.	
BELT CONVEYORS	**10 Hours**
General components of belt conveyors - Selection of belt speed and belt width – Drive unit design: Power requirement – coupling types and selection – Speed reduction: gearbox types and selection – Shaft and Pulley design – selection of Idlers and Idlers spacing – Safety devises for belt conveyors	

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DESIGN OF OTHER CONVEYORS	**10 Hours**
Apron conveyors, Screw conveyors, Cleat conveyors and Pneumatic conveyors	
ELEVATORS	**11 Hours**
Conveyors and Elevators – Bucket elevators: centrifugal type and continuous type bucket elevators– Design of bucket elevators – Safety devices for bucket elevators Cage elevators: Shaft way, guides, counterweights – safety devises	
HOIST	**10 Hours**
Design of Hoisting elements: Welded and roller chains – Hemp wire and ropes – Design of ropes – Pulley – sprockets and drums	
Load handling attachments – Forged and Eye hooks – crane grabs – lifting magnets – Grabbing. attachments – arresting gears and brakes	
Theory:45Hrs	**Total Hours:45**
REFERENCES:	
1. Rudenko N., "Materials handling equipment", ELnvee Publishers,1970.	
2. Fenner & Dunlop, "Conveyor Handbook"	
2. David VHutton "FundamentalsofFiniteElementAnalysis", McGraw-HillInternationalEdition, 2004.	
2. Alexandrov M, Materials Handling Equipments, MIR Publishers,1981.	
4. A. Spivakovsky(Author),V. Dyachkov(Author),D. Danemanis (Translator) Conveyors and Related Equipment, 1966.	

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U18MCE0012	DESIGN FOR MANUFACTURE AND ASSEMBLY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1	Explain the design principles for manufacturability and factors influencing it
CO2	List and explain the factors influencing form design.
CO3	Explain the design considerations for cast steel and casting process
CO4	Explain the design considerations various machining process.
CO5	Explain the use of computer in DFMA.
CO6	Describe the Design considerations and Guidelines for assembly.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	M													
CO2	M													
CO3	M		M										M	
CO4	M	W	S										M	W
CO5	M	W	M		W								M	
CO6	M		M										M	

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignment: Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable). 3. End Semester Examination	1.Course end survey

INTRODUCTION	9 Hours

General design principles for manufacturability –Factors influencing design-Types of problems to be solved-evaluation of customer's requirements-Systematic working plan for the designer-Types of problems to be solved-Possible Solutions-Evaluation method- Process capability - Feature.

tolerances -Geometric assembly. tolerances - Assembly limits -Datum features - Tolerance stacks-Interchangeable part manufacture and selective

FACTORS INFLUENCING FORM DESIGN	9 Hours

Materials choice - Influence of basic design, mechanical loading, material, production method, size and

weight on form design- form design of welded members and forgings-case studies	
COMPONENT DESIGN – CASTING CONSIDERATION	**9 Hours**
Form design of grey iron, steel, malleable iron and aluminum castings. Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores-case studies	
COMPONENT DESIGN - MACHINING CONSIDERATION	**9 Hours**
Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. Identification of uneconomical design - Modifying the design - Computer Applications for DFMA- case studies	
DESIGN FOR ASSEMBLY	**9 Hours**
Design for assembly (DFA) - The assembly process - Economic production quantities - Design considerations - Guidelines for assembly Improvement- Rivets - Screw fasteners - Metal stitching. – Fits - press-fits - snap-fits. Weldments - Characteristics and applications of arc weldments - Economic Production Quantities - Design Recommendations.	
Theory:45Hrs	**Total Hours:45**

REFERENCES:

1. Geoffrey Boothroyd, G,, Assembly Automation and Product Design. New York, Marcel Dekker,2011
2. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3. Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.

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U18MCE0013	PRECISION MANUFACTURING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Describe different types of Unconventional Machining processes and principle of mechanical energy based unconventional machining processes.	K2
CO2:	Explain the working principle of electrical energy based unconventional. machining processes.	K2
CO3:	Explain the working principle of chemical energy based unconventional. machining processes.	K2
CO4:	Explain the working principle of electro chemical energy based unconventional. machining processes.	K2
CO5:	Explain the working principle of thermal energy based unconventional machining. processes.	K2
CO6:	Describe the working principle of super finishing process.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	W												
CO2	M	M												
CO3	M	M											M	
CO4	M	M				W							M	W
CO5	M	M											M	
CO6	M	M											M	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. End semester Examination Assignment	1.Course end survey

MECHANICAL ENERGY BASED PROCESSES	**9 Hours**
Introduction Unconventional Machining Process, Need, Classification, Brief overview of all techniques, Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining- Ultrasonic Machining (AJM, WJM, AWJM, USM). Working Principles – equipment used – Process parameters – MRR – Applications.	
ELECTRICAL ENERGY BASED PROCESSES	**9 Hours**
Electric Discharge Machining (EDM) - working Principles-equipment-Process Parameters-MRR-electrodes Used – Power Circuits – Dielectric – Flushing – Applications, Wire Cut EDM Applications.	
CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES	**9 Hours**
Chemical machining and Electro-Chemical machining (CHM and ECM)-Etchants – Maskant-techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipment – MRR -Process Parameters- ECG and ECH - Applications.	
THERMAL ENERGY BASED PROCESSES	**9 Hours**
Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM), Principles-Equipment – MRR - Process Parameters - Applications.	
SUPER FINISHING PROCESS	**9 Hours**
Super finishing process – Honing - honing machines, Process parameter, MRR – Lapping – characteristics, Types of lapping, lapping machines, and Super finishing – Burnishing, Magnetic float polishing, Magnetic field assisted polishing, Electro polishing	
Theory:45Hrs	**Total Hours:45**
REFERENCES:	
1. Vijay K Jain "Advanced Machining Processes", first edition, Allied Publishers Pvt. Ltd., New Delhi, 2007.	
2. Benedict G F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987	
3. Pandey P C and Shan H S. "Modern Machining Processes", Tata McGraw-Hill, New Delhi, 1980.	
4. Hassan Abdel-Gawad El-Hofy "Advanced Machining Processes: Nontraditional and Hybrid Machining Processes" Tata McGraw-Hill, New Delhi, 2005	

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U18MCE0015	OPERATION RESEARCH	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Apply linear programming model and assignment model to domain specific situations.	K2
CO2:	Analyze the various methods under transportation model and apply the model for testing. the closeness of their results to optimal results	K2
CO3:	Apply the concepts of PERT and CPM for decision making and optimal management. projects	K2
CO4:	Analyze the various replacement and sequencing models and apply them for arriving at optimal decisions.	K2
CO5:	Analyze and apply appropriate inventory techniques in domain specific situations.	K2
CO6:	Analyze and apply appropriate queuing theories in domain specific situations.	K2

Pre-requisite

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	S	S		S									W	
CO2	S	S		S									W	
CO3	S	S		S						S			W	
CO4	S	S		S									W	
CO5	S	S		S									W	
CO6	S	S		S									W	

Nil

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. End semester Examination	1.Course end survey

LINEAR MODEL	**9 Hours**
The phases of OR study – formation of an L.P model – graphical solution – simplex algorithm – artificial variables technique (Big M method, two phase method), duality in simplex.	
TRANSPORTATION AND ASSIGNMENT PROBLEM	**9 Hours**
Transportation model – Initial solution by Northwest corner method – least cost method – VAM. Optimality test – MODI method and steppingstone method. Assignment model – formulation – balanced and unbalanced assignment problems. Traveling salesman problem	

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PROJECT MANAGEMENT BY PERT & CPM	**9 Hours**
Basic terminologies – Constructing a project network – Scheduling computations – PERT - CPM – Resource smoothening, Resource leveling, PERT cost	
REPLACEMENT AND SEQUENCING MODELS	**9 Hours**
Replacement policies - Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies). Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem	
INVENTORY AND QUEUING THEORY	**9 Hours**
Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management. Queuing system and its structure – Kendall's notation – Common queuing models - M/M/1: FCFS/∞/∞ - M/M/1: FCFS/n/∞ - M/M/C: FCFS/∞/∞ - M/M/1: FCFS/n/m	
Theory:45Hrs	**Total Hours:45**
REFERENCES:	
1. Taha H A., "Operation Research", Pearson Education, 2007.	
2. Hira and Gupta "Introduction to Operations Research", S. Chand and Co.2012	
3. Hira and Gupta "Problems in Operations Research", S. Chand and Co.2010	
4. Wagner, "Operations Research", Prentice Hall of India, 2000	

U18MCE0016	FINITE ELEMENT ANALYSIS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Develop the governing equations for a continuum.	K3
CO2:	Model and assemble the stiffness matrices for 1D, 2D elements.	K3
CO3:	Explain about plane stress and plane strain	K3
CO4:	Choose the appropriate element type for a particular application.	K3
CO5:	Apply the FEM for plate bending and thermal analysis	K3
CO6:	Apply different case study of finite element analysis	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	S	S							S		S	S		
CO2	S	S	M								S	S	M	
CO3	S		S		S						S		S	
CO4	S		S			S					S		S	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. End semester Examination. 4. Assignment	Course end survey

INTRODUCTION	**9 Hours**
Historical background – Introduction to FEA – Review of Matrix Algebra and Gaussian elimination – Governing equations for continuum – Spring assemblage – Stiffness method & Potential Energy Approach – Galerkin‟s weighted residual method.	
ONE DIMENSIONAL ELEMENTS – BAR, PLANE TRUSS & BEAM	**9 Hours**
Bar element - Stiffness Matrix in local and global coordinates, Computation of Stress – Potential EnergyandGalerkin‟sresidualmethod–SolutionofPlaneTruss–Beamelement–Stiffnessand assembly of stiffness matrices - Potential energy and Galerkin approach.	
PLANE STRESS & PLANE STRAIN – CST & LST APPROACH	**8 Hours**

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Binomial, Poisson and Normal distributions – properties- Fitting of Binomial, Poisson and normal distributions to data	
AXISYMMETRIC ELEMENTS AND ISOPARAMETRIC FORMULATION	**10 Hours**
Axisymmetric formulation – Stiffness Matrix – Pressure Vessel Analysis – Applications – Isoperimetric formulation – Formulation for Bar and Plane Elements – Numerical Integration – Gaussian & Newton-Cotes Quadrature – Evaluation of Stiffness Matrix by Gaussian Quadrature.	
PLATE BENDING AND THERMAL ANALYSIS	**9 Hours**
Basic Concepts of Plate Bending – Element Stiffness Matrix and Equations – Heat Transfer – Basic Differential Equation and Units – 1d and 2d formulation.	
CASE STUDY: Finite Element Analysis on Bicycle Frame, Finite Element Analysis on V-belt pulley of a fodder crushing machine.	
Theory:45Hrs	**Total Hours:45**
REFERENCES:	
1. Daryl, L. Logan, "A First course in the Finite Element Method", Thomson Learning, 4th edition, 2007.	
2. Chandrupatla T.R., and Belegundu A.D.," Introduction to Finite Elements in Engineering", Pearson Education, 3rd Edition, 2002.	
3. David V Hutton "Fundamentals of Finite Element Analysis", McGraw-Hill International Edition, 2004.	
4. Rao S.S., "The Finite Element Method in Engineering", Pergammon Press, 1989.	
5. N. Reddy, "An Introduction to the Finite Element Method", Tata McGraw Hill, 3rd Edition, 2005.	

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U18MCE0017	MAINTENANCE ENGINEERING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Extend the concept and function of maintenance department and costs associated.	K2
CO2:	Plan for preventive maintenance.	K2
CO3:	Schedule and evaluate the maintenance.	K2
CO4:	Test the reliability in maintenance.	K2
CO5:	Analyze manpower requirement.	K2
CO6:	Explain the maintenance of mechanical and electrical systems.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M								S				S	
CO2		M	M									W		S
CO3			M										M	
CO4											S		S	
CO5									S					S
CO6	S													S

Course Assessment methods:

Internal test I	Internal test I
1. Internal Test I 2. Internal Test II 3. Group Presentation 4. End Semester exam	Course end survey

MAINTENANCE CONCEPT	**9 Hours**

Maintenance objectives, levels, types of systems, benefits, effects – Responsibilities of maintenance department – Concept of maintainability – Principles of Maintenance – R&D, Overhauling and Expert systems in Maintenance, Maintenance cost and budget.

PLANNED PREVENTIVE MAINTANANCE	**9 Hours**

Scope and elements of PPM, Implementation, work planning and scheduling Planned maintenance procedure, effectiveness of preventive maintenance, development of checklist.

MAINTENANCE EVALUATION, PLANNING AND SCHEDULING	**9 Hours**

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Maintenance evaluation, planning of maintenance function, development of maintenance department, estimation of maintenance work maintenance scheduling.	
RELIABILITY IN MAINTENANCE	**9 Hours**
Reliability, failure functions and their models, application, design for reliability, quality and reliability, reliability improvement and testing.	
MANPOWER PLANNING MAINTENANCE OF MECHANICAL AND ELECTRICAL SYSTEMS	**9 Hours**
Manpower planning: Objectives, stages, Timescale, Estimation Mode, Maintenance of Bearings, Friction clutches, Couplings, Fastening devises, Chains, Gear Drives, Support Equipment, Electrical Equipment.	
Theory:45Hrs	**Total Hours:45**

REFERENCES

1. Mishra, R.C., K. Rathak, Maintenance Engineering and Management, Prentice Hall of India, 2ndEdition, 2012.
2. Er. Sushil Kumar Srivastava, Maintenance Engineering (Principles, Practices and Management) S. Chand

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U18MCE0018	MEDICAL MECHATRONICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1	Explain different measurement techniques used in physiological parameters measurement.	K2
CO2	Describe the different sensors and transducer principles used in bio medical application	K2
CO3	Describe the signal conditioning circuits used in biomedical engineering.	K2
CO4	Comment on various measurement systems used in diagnostics.	K2
CO5	Comment on various monitoring systems used in diagnostics	K2
CO6	Differentiate the working of recorders and explain the advanced systems used in medicine.	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	M											M	M	M
CO2	M			W								M		
CO3	M			M								M	W	
CO4	M	W										M		M
CO5	M	W										M	M	
CO6	M				M							M		

Course Assessment methods:

Internal test I	Internal test I
Internal test I Internal test II End semester Examination. Assignment	Course end survey

INTRODUCTION	**9 Hours**
Introduction to the physiology of cardiac, nervous & muscular and respiratory systems. Transducers and Electrodes: Different types of transducers & their selection for biomedical applications. Electrode theory, selection criteria of electrodes & different types of electrodes such as, Ag – Ag Cl, pH, etc.	
BIO-MEDICAL SENSORS AND TRANSDUCERS	**9 Hours**
Basic transducer principle Types — resistive, inductive, capacitive, fiber-optic, photoelectric, chemical, active and passive transducers and their description and feature applicable for biomedical instrumentation – Bio, Nano sensors and application.	

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BIO AMPLIFIER	**9 Hours**
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference	
MEDICAL MEASUREMENT AND MONITORING SYSTEMS	**9 Hours**
Blood pressure measurement: by ultrasonic method – plethysmography – blood flow measurement by electromagnetic flow meter, cardiac output measurement by dilution method – phonocardiography – vector cardiography. Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – cardiac pacemaker –defibrillator patient safety - electrical shock hazards - Centralized patient monitoring system.	
RECORDERS AND ADVANCED SYSTEMS	**9 Hours**
Oscillography – galvanometric - thermal array recorder, photographic recorder, storage oscilloscopes, electron microscope. Biotelemetry, Diathermy, Audiometers, Dialyzers, Lithotripsy. **CASE STUDIES: Hot wire Anemometry for respiratory flow measurements.**	
Theory:45Hrs	**Total Hours:45**

REFERENCES

1. Khandpur R S., "Handbook of Biomedical Instrumentation", TMH, 2014
2. Cromwell, Weibel and Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd edition, Prentice Hall of India, 2011.
3. Geddes L.A., and Baker, L.E., Principles of Applied Bio-medical Instrumentation, 3rd Edition, John Wiley and Sons, 2010
4. Tompkins W J., "Biomedical Digital Signal Processing", Prentice Hall of India, 2000.
5. Arumugam M," Bio-Medical Instrumentation", Anuradha Agencies, 2006.

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OPEN ELECTIVES

U18MCO0001	ROBOTICS FOR ENGINEERS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Describe about the robot laws, kinematics and dynamics	K3
CO2:	Discuss about various robotic drives and control	K2
CO3:	Illustrate the various sensor used in robotic control	K2
CO4:	Brief about the image optimization techniques	K3
CO5:	Discuss about the application of robots in various fields	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S										S	S
CO2	S		M								S	S
CO3	S	S				W					S	
CO4	S					W					S	S
CO5	S		M					M			M	M

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	1. Course -end survey

INTRODUCTION	**10 Hours**
Evolution of robotics - Laws of robotics – classification - robot anatomy – specification – Resolution, repeatability and precision movement. Introduction to robot arm kinematics and dynamics – planning of manipulator trajectories.	
ROBOTIC DRIVES AND CONTROL	**10 Hours**
Hydraulic, Electric and Pneumatic drives – linear and rotary actuators – end-effectors – classification-control of robot manipulator - variable structure control – non-linear decoupled and feedback control – effect of external disturbance – PID control scheme – resolved motion control - computed torque control, force control of robotic	

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manipulators. Adaptive control.	
SENSORS	**10 Hours**
Need for sensing system - classification of robotic sensors - status sensors, environmental sensors, quality control sensors, safety sensors and work cell control sensors. – non-optical and optical position sensors – velocity sensors – proximity sensors – contact and noncontact type – touch and slip sensors – force and torque sensors – selection of right sensors.	
MACHINE VISION SYSTEM	**10 Hours**
Image Sensing and Digitizing - Image definition, Image acquisition devices, specialized lighting techniques. Digital Images - Sampling, Quantization and Encoding. Image storage. Image Processing and Analysis Data reduction – digital conversion and windowing. Segmentation – Thresholding, Edge detection and Region growing. Binary Morphology and grey morphology operations. Feature Extraction, Object recognition, Depth measurement.	
APPLICATION	**5 Hours**
Introduction - Delivery Robots – Intelligent vehicles – Survey and inspection robots – Space Robots – Autonomous aircrafts – Underwater Inspection – Agriculture and Forestry.	
Theory:45Hrs	**Total Hours:45**

REFERENCES

1. Saeed B Niku, 'Introduction to Robotics', 2nd edition, Prentice Hall of India, 2010.
2. S. R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Mikell P. Groover, "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
4. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987
5. Ramesh Jam, Rangachari Kasturi, Brain G. Schunck, "Machine Vision", Tata McGraw-Hill, 1995.
6. Yoremkoren, "Robotics for Engineers", McGraw-Hill, USA, 1987.
7. P.A. Janaki Raman, "Robotics and Image Processing", Tata McGraw-Hill, 1991.

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U18MCO0002	AUTOMATION IN AGRICULTURE	L	T	P	J	C
		2	0	1	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	To understand the basics of automation in agriculture.	K2
CO2:	To understand the concepts of Precision agricultural systems and trends	K2
CO3:	To understand importance of automation in Irrigation systems	K2
CO4:	To understand the various Automation Practices in agriculture through case studies.	K2
CO5:	To know the Applications in material handling and packaging industries	K2

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	S												S	
CO2	S					W								M
CO3	S			S										M
CO4	S			S				W					S	
CO5		M		S				W					S	

Course Assessment methods:

DIRECT	INDIRECT
5. Internal Test I 6. Internal Test II 7. Assignment 8. Group Presentation 9. End semester exam	Course end survey

AUTOMATION IN AGRICULTURE	**10 Hours**
Introduction to automation- Robot farming system –wheel type robot tractor, crawler type robot tractor, rice planting robot, robot combine harvester – sensing crop status.	
PRECISION AGRICULTURAL SYSTEMS	**10 Hours**
Soil sensors- crop sensors – yield monitors –remote sensing- airborne multispectral and hyperspectral imaging-satellite imaging system- Principle – applications	
IRRIGATION SYSTEMS	**15 Hours**

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Introduction –Types of irrigation system GIS in irrigation -Planning and design – rain fall monitoring-drought monitoring- automated controller-based irrigation system-IOT based irrigation system- case study evaluation of irrigation system in agriculture.	
AUTOMATION PRACTICES	**10 Hours**
Field crop production automation – Mechanization, Sensing and Control in cotton production – Automatic Rubber Tapping	
Theory: 45	**Total Hours:45**
REFERENCES	
1.	Qin Zhang, Francis J. Pierce, "Agricultural Automation: Fundamentals and Practices", CRC Press, A Chapman and Hall Book, 2013
2	Qin Zhang, "Precision Agriculture Technology for Crop Farming", CRC Press, 2016.
3	Irrigation Systems, A Laycock, Irrigation Systems-Design, Planning and Construction ,2011
4	Shimon Y Nof, Springer Handbook of Automation ,2009.
5	Jensen, J.R., 2004. "Introductory Digital Image Processing: A Remote Sensing Perspective". Prentice – Hall. New Jersey.
6.	A.M. Michael, 2010. Irrigation - theory and practice, Vikas publishers, New Delhi.
7	http://cyber.sci-hub.tw/MTAuMTIwMS9iMTkzMzYtMTE=/10.1201%40b19336-11.pdf /
8	https://link.springer.com/chapter/10.1007/978-3-540-78831-7_63
9	https://www.safaribooksonline.com/library/view/agricultural-systems-agroecology/9780128020951
10	http://sci-hub.tw/10.1080/10106048709354084
11	https://www.safaribooksonline.com/library/view/sustainable-water-engineering/9781118541029/
12	https://www.coursera.org/specializations/gis

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U18MCO0004	NATURE INSPIRED OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the importance of optimization (K2)

CO2: Understand nature inspired optimization algorithms (K2)

CO3: Apply nature inspired optimization techniques to solve problems (K4)

Pre-requisites: Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	M										M	M
CO2	M	S	S										M	M
CO3	S	S	M	M	S								S	S

Course Assessment methods:

Direct	Indirect
Written Assignment Case Studies Simulation	Course end survey

MODULE 1 **9 Hours**

Introduction to Optimization – Single and Multi-Objective Optimization – Nature Inspired Optimization – Genetic Algorithms – Gene Programming – Case Studies.

MODULE 2 **9 Hours**

Particle Swarm Optimization – Ant Colony Optimization – Bees Algorithm – Artificial Bee Colony Optimization – Case Studies.

MODULE 3 **9 Hours**

Cuckoo Search Algorithm – Firefly Algorithm – Fish Swarm Algorithm – Case Studies.

MODULE 4 **9 Hours**

Grey Wolf Algorithm – Bat Algorithm – Ant Lion Optimization – Case Studies.

MODULE 5 **9 Hours**

Flower Pollination Algorithm - Crow Search Algorithm – Water Wave Optimization - Case

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Studies.
Theory: 45 Hrs **Total Hours: 45**
REFERENCES:
1. Xin-She Yang, Nature-Inspired Optimization Algorithms, Elsevier, 2016.
2. Omid Bozorg-Haddad (Editor), Advanced Optimization by Nature-Inspired Algorithms, Studies in Computational Intelligence, Springer, 2017.
3. Ke-Lin Du, M.N.S. Swamy, Search and Optimization by Metaheuristics, Techniques and Algorithms Inspired by Nature, Birkhauser, 2016.
4. www.ieeeexplore.org
5. www.elsevier.com
6. www.springer.com

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U18MCO0005	Mechanics in Cricket	L	T	P	J	C
		3	0	0	0	3

Course OBJECTIVES

1. To encourage, support and motivate the students to learn and understand concepts with a real-time thing or with a sport related activity
2. To know the design aspects and mechanics behind the sports equipment designs
3. To develop goal oriented synergetic approach by rectifying errors in the pressure situations
4. To develop team spirit and be a team worker.
5. To analyze and anticipate the changes in the game and thereby reacting according to the situation

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Understand the basic principles, rules and regulations and the skills of the game, tactics, field placement and umpiring signals	K2
CO2:	Interpret the technical knowledge in the aspects of cricket	K3
CO3:	Illustrate and make use of material science concepts in the design of cricket equipments	K3
CO4:	Apply and interpret the knowledge of solid mechanics and fluid mechanics in the batting and bowling aspects of cricket	K3
CO5:	Discover and explain the applications of sensor and instrumentation in the game of cricket	K3

Pre-requisite

U17MET2003 Engineering Mechanics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1			M							M		M		
CO2	S	S	W							M		M	M	M
CO3	W	W	S							M		M	M	M
CO4	S	S	S							M		M	M	M
CO5	M	M	S							M		M	M	M

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignments, Journal paper review, Group Presentation, Prototype or Product Demonstration Open book test, Quiz etc. (as applicable) 3. End Semester Examination	1. Course-end survey

Introduction to the Game of Cricket	**9 Hours**

Introduction – Evolution of cricket – Basic rules and regulations – Various types or levels of cricket – Ground,

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Pitch and equipment's, Ground and pitch preparation, Physical conditioning for cricket, Stamina improvement exercises for batting, bowling and fielding. Batting – Batting posture - Stance, Bat lift, Position and orientation of bat for various types of shots or strokes Bowling - Bowling – Ball grip, seam position and its effects in trajectory of the ball – Seam and Face bowling – Various Slower delivery techniques - Naku Ball, Split Finger, Leg cutter, Off cutter, Position and orientation for various Spin Bowling – Leg Spin, Off Spin, Top spin, Chinaman, Googly, Carom ball	
Various Aspects of Cricket Player and Umpire	**9 Hours**
Fielding – Fielding Positions, Judgments according to field positions, Field adjustments according to trajectory of bowlers, catching – Low, Flat, High catches at different positions, Slip catching, Throwing – Under arm, Flat, Long throw. Wicket-keeping – Stance for spin and pace / seam bowling – Upto the stumps, Behind the stumps, Stumping, Run-outs. Umpiring – 42 laws of cricket – interpretation and its application, Different signals – Stance and movements for runouts, Eligibility criteria, Calculations for Organizing a cricket tournament – Matches, Run-rate	
Material Science and Composite Materials in Cricket	**9 Hours**
Various types of cricket – Depends on ball usage – White, Red, Pink - SG, Kookaburra, Dukes – Various design considerations in the design of cricket bats and balls – CNC Machines in design of bats - Various materials used for the design of cricket bat – Aluminum, Carbon composite, Graphite – Handle materials – Cane, Willow, Rubber, Polyurethane – Design modifications in Cricket Bat – Selection of cricket bats – Knocking of bats	
Solid Mechanics and Fluid Mechanics in Cricket	**9 Hours**
Fluid mechanics related to Ball Swing – Inswing, Out Swing, Reverse Swing – Laminar and Turbulent flow. Case studies: Smith, Warner and Bancroft ban issue – Various ball tampering incidents - Captaincy – Player managements, Field Placements related to bowlers and strengths of batsmen, Pressure situation analysis, reacting according to the situations on and off the field, motivational aspects for players. Solid mechanics related to Ball – Bat Contact and Trajectory – Conservation of momentum, Impact of elastic bodies, Curvilinear motion - Projectile motion – Ball validation related to Co-efficient of restitution	
Sensor and Instrumentation in Cricket	**9 Hours**
Go and No-Go Gauges for ball circularity measurement – Hawk Eye – Snicko meter – Hot Spot – Light Meter – LED Stumps – Ball Speed Sensor – Bat Swinging Speed Sensor (Intel) – Drone for Pitch Analysis - Bowling action verification	
Theory: 45 Hours	**Total: 45 Hours**
REFERENCES	
1. The Handbook of Cricket, K. V. Andrew	
2. The Skills of Cricket, K. V. Andrew	

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OTHER REFERENCES

1. Cricket – The Techniques of the Game, Andrew, Carter, Lenham
2. A History of Cricket, B. Green
3. The MCC Cricket Coaching Book (Fourth Edition)
4. Wisden Cricketers' Almanack (Printed Annually)
5. Test Cricket in Clubs and Schools (Available from NCA)
6. How to Coach Cricket, R. Dellor
7. Games for Cricket Training, A. Oakman
8. The Laws of Cricket (1980 Code) Second Edition 1992.

U18MCO0006	LOW-COST AUTOMATION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	To provide basic knowledge to implement low-cost Automation in various industries	**K2**
CO2:	To study the pneumatics devices and circuits and its applications	**K2**
CO3:	To understand the Hydraulic devices and circuits	**K2**
CO4:	To configure the Automation assembly lines used in industries	**K2**
CO5:	To know the Applications in material handling and packaging industries	**K2**

Pre-requisite

U17MET2003 Engineering Mechanics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	S												S	M
CO2	S												S	M
CO3	S		M		M								S	M
CO4	S		M		M								S	M
CO5	S												S	M

Course Assessment methods:

DIRECT	INDIRECT
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group Presentation 5. End semester exam	Course end survey

INTRODUCTION TO AUTOMATION	**5 Hours**

Automated manufacturing systems, fixed /programmable /flexible automation, Need of automation, Basic elements of automated systems- power, program and control. Levels of automation; control systems: Continuous and discrete control; Low-cost automation, Economic and social aspects of automation.

BASICS OF PNEUMATICS AND CIRCUIT DESIGN	**12 Hours**

Operational principles and application, air compressors, Pneumatic cylinders and air motors, Pneumatic valves, Design of pneumatic circuits: speed control, reciprocating, synchronization and sequencing circuits. Hydro-pneumatic, Electro pneumatic Control in pneumatic systems.

BASICS OF HYDRAULICS AND CIRCUIT DESIGN	**12 Hours**

Principles of hydraulics, Hydraulic fluids, Filtration technology, Hydraulic- pumps, valves, and actuators. Standards in circuit diagram representation, Power pack design layout, Basic hydraulic circuits.	
ASSEMBLY AUTOMATION:	**8 Hours**
Types and configurations, Parts delivery at workstations-Various vibratory and non-vibratory devices for feeding, hopper feeders, rotary disc feeder, centrifugal and orientation, Product design for automated assembly.	
APPLICATIONS AND CASE STUDIES:	**8 Hours**
Material handling- sorting- door opening- labelling Alignment method examples- Direction Change- Automatic Screw Fastening- locking and clamping devices**.**	
Theory: 45 Tutorials: 0-hour Total Hours:45	

REFERENCES

1.	Anthony Esposito, "Fluid Power with applications", Prentice Hall international, 2014.
2	Mikell P Groover, "Automation, Production System and Computer Integrated Manufacturing", Prentice Hall Publications, 2016.
3	Kuo.B.C, "Automatic control systems", Prentice Hall India, New Delhi, 2007.
4	James A Sullivan, "Fluid power Theory and Applications", 4th edition, C.H.I.P.S, 2007.
5	Mujumdar.S. R, "Pneumatic System", Tata McGraw Hill 2009
6.	. E.G. Phillips, "Pneumatic conveying", 2017.

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U18MCO0007	MAGICS AND MECHANICS	L	T	P	J	C
		2	0	1	0	3

Course OBJECTIVES

1. To understand the mechanical engineering terminologies related to electrical/control/instrumentation engineering.
2. To understand the Modes of Heat transfer.
3. To understand thermoelectric power generation.

Course Outcomes

After successful completion of this course, the students should be able to		
CO1:	Illustrate the mechanical terminologies and compare them with appropriate electrical terminologies.	
CO2:	Find the resultant of force system, resolution of forces.	
CO3:	Solve the problems related to frictional losses.	
CO4:	Describe inertia and its effects on drive selection.	
CO5:	Analyze the heat transfer rate and thermoelectric power generation.	

Pre-requisite

U17MET2003 Engineering Mechanics

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	S	S			W					M	M	M	M	
CO2	S	S												
CO3	S	S										S		M
CO4	M													
CO5	M	M												

Course Assessment methods:

DIRECT	INDIRECT
1. Continuous Assessment Test I, II 2. Assignments, Journal paper review, Group Presentation, Prototype or Product Demonstration Open book test, Quiz etc. (as applicable) 3. End Semester Examination 4. Classroom teaching. 5. Magic Demonstrations. 6. Peer learning.	1. Course-end survey

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FORCE AND MECHANICS	**12 Hours**
Engineering Mechanics, units and dimensions, mass, weight, pressure, velocity, acceleration, electrical analogy, force and reaction, resultant, resolution of forces.	
THE MAGIC BALL AND THE NECESSARY EVIL	**8 Hours**
Friction, laws of friction, calculation of frictional forces, losses due to friction, Electrical analogy.	
WILL THE DUSTER MOVE ALONG WITH PAPER?	**10 Hours**
Mass, inertia, applications of inertia, inertial effect on drivers. Moment of inertia, Calculation of moment of inertia and inertial effects on drivers.	
WORK ENERGY AND POWER	**4 Hours**
Moment, torque, work, energy, power, electrical analogy.	
INTRODUCTION TO HEAT TRANSFER AND THERMOELECTRIC POWER GENERATION	**11 Hours**
Electrical heat generation, Modes of heat transfer, thermoelectric power generation.	
Theory: 45 Hours	**Total: 45 Hours**

TEXTBOOKS

1. Ferdinand P. Beer& E. Russell Johnston., "Vector Mechanics for Engineers, Statics and Dynamics", McGarw Hill 2017.
2. Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine, "Principles of Heat and Mass transfer", Wiley 2015.

REFERENCE BOOKS

1. David Halliday, Jearl Walker, and Robert Resnick, "Fundamentals of Physics",4th edition, Wiley.2015

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INDUSTRY OFFERING ELECTIVE

U18MCE0019	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Apply concepts of product development and outline product planning process
CO2:	Apply relative importance of customer needs in establishing product specifications
CO3:	Identify concept generation activities and summarize the methodology involved in concept selection and testing
CO4:	Outline supply chain considerations in product architecture and understand theindustrial design process
CO5:	Apply design for manufacturing concepts in estimating manufacturing costs
CO6:	Apply principles of prototyping in product development economics and highlight importance of managing projects

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M		M					W			M	
CO2			M										M	
CO3	M		M										S	
CO4			S			W				M	M		M	
CO5			S		M	M								S
CO6					M				M		S			S

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation. 5. End semester exam	Course end survey

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING	**9 Hours**

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product developmentorganizations, the AMF organization.

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The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS	**9 Hours**

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING	**9 Hours**

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflects on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING	**9 Hours**

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING PRODUCT DEVELOPMENT ECONOMICS MANAGING PROJECTS	**9 Hours**

Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing tasks, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

REFERENCES:

1. Karl Ulrich, T, Steven Eppinger, D, "Product Design and Development", McGraw Hill,2015.
2. Chitale, AK, Gupta, RC, "Product Design and Manufacturing" PHI, 2013.
3. Timjones, "New Product Development: An Introduction to a multifunctional process", Butterworth-Heinemann, 1997.
4. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, A, "Product Design forManufacture and Assembly", CRC Press, 2011.

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U18MCE0020	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Apply concepts of product lifecycle management and visioning
CO2:	Apply relative importance of product concepts, processes and workflow
CO3:	Apply principles of collaborative product development
CO4:	Outline considerations in system architecture understand the industrial process
CO5:	Apply product lifecycle management strategy and assessment
CO6:	Apply the infrastructure assessment, assessment of current systems and applications.

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M		M					W			M	
CO2			M										M	
CO3	M		M										M	
CO4			S			W				M	M		M	
CO5			S		M	M								S
CO6						M							M	

Course Assessment methods:

Direct	Indirect
1. Internal Test I 2. Internal Test II 3. Assignment 4. Group presentation. 5. End semester exam	Course end survey

INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT	**6 Hours**

Definition, PLM Lifecycle Model, Threads of Product Lifecycle Management, Need for Product Lifecycle Management, Opportunities and Benefits of Product Lifecycle Management, Views, Components and Phases of Product Lifecycle Management, Product Lifecycle Management feasibility study, Product Lifecycle Management Visioning.

PLM CONCEPTS, PROCESSES AND WORKFLOW	**6 Hours**

Characteristics of Product Lifecycle Management, Environment Driving Product Lifecycle

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Management, Product Lifecycle Management Elements, Drivers of Product Lifecycle Management, Conceptualization, Design, Development, Validation, Production, Support of Product Lifecycle Management.

COLLABORATIVE PRODUCT DEVELOPMENT	**6 Hours**

Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Bill of Materials and Process Consistency, Digital Mock-Up and Prototype Development, Designfor Environment, Virtual Testing and Validation, Marketing Collateral.

SYSTEM ARCHITECTURE	**6 Hours**

Introduction, Types of Product Data, Product Lifecycle Management systems, Features of Product Lifecycle Management System, System architecture, Product information models, Functionality of the Product Lifecycle Management Systems

DEVELOPING A PLM STRATEGY AND ASSESSMENT	**9 Hours**

Strategy, Impact of strategy, implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.

PRACTICAL:	**30 Hours**

1. Streamline collaboration to capture and manage the creation, revision, release of CADdata simulation models and documentations.
2. Create, assign and mange task, setting priorities of task to the teams on track,
3. Resolving issues (issue management)
4. View and markup complex 3D product design
5. Change management capabilities.
6. Customization and implementation of various industrial practices
7. Conceptualization for Product Lifecycle Management
8. Validation for Product Lifecycle Management
9. Building Product information models

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

REFERENCES:

1. Michael Grieves, Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Mc Graw Hill, 2015.
2. Martin Eigner, System Lifecycle Management – Engineering Digitalization (Engineering 4.0), Springer Vieweg 2021.
3. Karl Ulrich, T, Steven Eppinger, D, "Product Design and Development", McGraw Hill, 2015
4. Chitale, AK, Gupta, RC, "Product Design and Manufacturing" PHI, 2013.

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U18ECE0057	INTRODUCTION TO HMI	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1: Explain the applications of HMIs in various domains	K2
CO2: Differentiate various communication protocols used in HMI Development	K2
CO3: Describe car multimedia systems and the hardware, software evolution	K2
CO4: Summarize various tools used for HMI development for automobile application	K2
CO5: Explain the importance of user experience with a case study.	K2
CO6: Use various graphic tools and advanced techniques to create UI's	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	W												M
CO2	M	S												M
CO3		M	M											M
CO4		S		M										M
CO5		M	M		M									M
CO6		M	M		M									M

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	Course end survey

INTRODUCTION TO HMI AND AUTOMOTIVE ELECTRONICS	**6 Hours**
HMI use cases for Automotive, Industrial, Consumer Electronics, Medical and Aero - ECUs within cars and their functionalities. Communication protocols for ECUs. (CAN, LIN, Most, Flex Ray, Ethernet)	
CAR MULTIMEDIA	**9 Hours**
Instrument Cluster, In Vehicle Infotainment, Professional Systems, Rear Seat Entertainment - Evolution of car multimedia, Overview, H/W, S/W and mechanics	
AUTOMOTIVE HMI	**9 Hours**
HMI Architecture & Concepts, H/W Platform(intel, Qualcomm,i.MX6), S/W Platform(OS, Graphics libraries	

and Connectivity), Services(Navigation, map Engine, Alexa), Application Framework(Qt, Android sdk, CGISTUDIO, IAR SYSTEMS), HMI domain specific applications - HMI application components, Widgets, Framework, Framework model and state machine.	
UX AND UI	**10 Hours**
Introduction to UX design - stages, theory, Design thinking, UX Case Studies, Comparison of UX and UI, Interaction concepts, Graphic design with introduction to tools (Adobe Photoshop, Adobe XD, Blender) - Asset Design - Overview only, Guidelines and norms, 2D/3D rendering.	
TRENDS AND ADVANCED TOPICS	**10 Hours**
Voice, Gesture, Vision, sensor based UI controls, Haptics, New technologies (eye gaze, gesture, dual display), SPI - android auto, car play, Smart City and Public Transport, ride sharing, personal, Virtual Reality , Augmented Reality and Mixed Reality, UI Analytics (Usage patterns), Debugging, Performance Profiling	
Theory: 45 Hours	**Total Hours: 45**
REFERENCES:	
1. Shuo Gao, Shuo Yan, Hang Zhao, Arokia Nathan, "Touch-Based Human-Machine Interaction: Principles and Applications ", Springer Nature Switzerland AG; 1st edition,2021.	
2. Robert Wells, "Unity 2020 By Example: A project-based guide to building 2D, 3D, augmented reality, and virtual reality games from scratch", Packt Publishing Limited, 2020.	
3. Ryan Cohen, Tao Wang, "GUI Design for Android Apps", A press, Berkeley, CA, 2014.	

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U18ECE0058	Advanced HMI	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1: Summarize HMI architecture and its subcomponents	K2
CO2: Develop real time automotive applications using tools such as Unity and Qt.	K3
CO3: Develop simple HMI using Android and Web app development tools	K3
CO4: Perform HMI testing and validation for the developed system	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	W												M
CO2	M	S												M
CO3		M	M											M
CO4		S		M	M									M

Course Assessment methods:

Direct	Indirect
4. Continuous Assessment Test I, II 5. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 6. End Semester Examination	Course end survey

INTRODUCTION	**2 Hours**
HMI Architecture & Concepts, HMI Subcomponents	
GAMING ADVANCED 3D DEVELOPMENT	**9 Hours**
Introduction to game development and advanced 3D development, Game Engine, Unity 3D – installation -code editor – camera - game objects and transform – Renderer – lighting – UI – Scripting, Realtime 3D in Automotive world, HMI Development.	
QT	**8 Hours**
History of QT, Why Qt? Supported Platforms, Qt Installation, Qt Creator, Qt Modules, Signals and slots, Event Processing.	
ANDROID AND WEB APP DEVELOPENT	**8 Hours**

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Android, PWA, HTML CSS JavaScript (Front End Frameworks)	
HMI TESTING AND AUTOMATION	**3 Hours**
Introduction, elements of HMI, Challenges of HMI Testing, Verification and Validation	
Theory: 30 Hours **Practical: 15 Hours** **Total Hours: 45**	
REFERENCES:	
1. Shuo Gao, Shuo Yan, Hang Zhao, Arokia Nathan, "Touch-Based Human-Machine Interaction: Principles and Applications ", Springer Nature Switzerland AG; 1st edition,2021.	
2. Robert Wells, "Unity 2020 By Example: A project-based guide to building 2D, 3D, augmented reality, and virtual reality games from scratch", Packt Publishing Limited, 2020.	
3. Lee Zhi Eng , "Qt5 C++ GUI Programming Cookbook: Practical recipes for building cross-platform GUI applications, widgets, and animations with Qt 5, 2nd Edition, Packt Publishing Limited, 2019.	
4. .Karim Yaghmour, "Embedded Android: Porting, Extending, and Customizing", First Edition, Shroff/O'Reilly, 2013	
5. Louis J.Williams, "Basic Programming Android for beginners Handbook", IT Campus Academy, March 2016	
7. Julie C. Meloni, "Sams Teach Yourself HTML, CSS, and JavaScript All in One", Pearson Education, 2011.	
8. Arnon Axelrod, "Complete Guide to Test Automation by Arnon Axelrod", a Press, September 2018.	
8.Dean Alan Hume, "Progressive Web Apps", Manning Publisher, December 2017.	
LIST OF EXPERIMENT:	
1. Setting up of Raspberry Pi with capacitive touch screen	
2. Setting up the Unity environment.	
3. Working with UI controls of Unity.	
4. Qt Installation and configuration.	
5. Creating Dialogs and Main windows using Qt programming.	
6. Working with building blocks of practical web design using HTML	
7. Webpage design with CSS and Form validation using JavaScript.	

ONE CREDIT COURSE

U18MCC0001	ROBOT OPERATING SYSTEM	L	T	P	J	C
		1	0	0	0	1

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Explain the importance and different frameworks of ROS

CO2: Use the Linux command in the Terminal window

CO3: Describe the various computation graph-level concepts in ROS

CO4: Use debugging and visualization tools in ROS

CO5: Implement communication protocols for wired and wireless communication

CO6: Design robots by interfacing with motors and cameras

Pre-requisite

-

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		M	M	S									
CO2	S		M		S									
CO3	S		M	M	S									
CO4	S		M		S									
CO5	S		M	M	S									
CO6	S		M	M	S									

Course Assessment methods:

Direct	Indirect
Internal test I Internal test II End semester Examination. Assignment	Course end survey

INTRODUCTION TO ROS	2 Hours

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Introduction - history - distributions - difference from other meta - operating systems -services - ROS framework - operating system – releases	
INTRODUCTION TO LINUX COMMANDS	**2 Hours**
LINUX commands - file system - redirection of input and output - File system security - Changing access rights - process commands - compiling, building, and running commands -handling variables.	
ARCHITECTURE OF THE OPERATING SYSTEM	**2 Hours**
File system - packages - Stacks - messages - services – catkin workspace - working with catkin workspace - working with ROS navigation and listing commands.	
COMPUTATION GRAPH LEVEL	**2 Hours**
Navigation through file system - Understanding of Nodes - topics - services - messages - bags - master - parameter server - interfacing of Sensors and Actuators	
DEBUGGING AND VISUALIZATION	**2 Hours**
Debugging of Nodes - topics - services - messages - bags - master parameter - visualization using Gazebo - Rviz - URDF modeling - Xacro - launch files.	
APPLICATIONS	**5 Hours**
ROS Robotics - Single-board Computers, ROS on Raspberry Pi, Jetson Nano	
Theory: 15 Hours.	**Total Hours: 15 Hours**
REFERENCES:	
1. Lentin Joseph, Jonathan Cacace "Mastering ROS for Robotics Programming", 3rd edition, Packt Publishing Limited, 2021.	
2. Ramkumar Gandhinathan, Lentin Joseph, "ROS Robotics Projects", 2nd Edition, Packt Publishing Limited ,2019.	

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LANGUAGE ELECTIVE

U18FRI2201	FRENCH LEVEL I (*Common to all*)	L	T	P	J	C
		2	0	2	0	3

Course Objectives:

1. To train the students to learn basic French.
2. To teach them to learn basic grammar and vocabulary.
3. To train them to converse in French in day-to-day scenarios.

Course Outcomes:

After the course the students will be able to:

CO1: to help students acquire familiarity in the French alphabet & basic vocabularyCO2: listen and identify individual sounds of French.

CO3: use basic sounds and words while speaking.

- read and understand simple advertisements, brochures and invitations.
- understand and use basic grammar and appropriate vocabulary in completinglanguage tasks.

Assessment Methods:

Direct
1. Continuous Assessment of Skills 2. Assignment 3. Written Test 4. End Semester Examination
Indirect
1. Course-end survey

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CO/PO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSO**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1									**S**	**S**		**S**		
CO2									**S**	**S**		**S**		
CO3									**S**	**S**		**S**		

UNIT – 1

Introduction to France and its regions - French alphabets and numbers, countries andnationality	**12 Hours**
Grammaire – Verbs – s'appeler, être, avoir, definite and indefinite articlesCommunication – Greetings, Self-Introduction	

UNIT II

Basic vocabulary, colours, months and days	**12 Hours**
Grammaire - Verbes - Conjugation: Present tense (ER, IR, RE ending verbs) – Adjective possessive Communication – Talk about family and friends, date, time etc.	

UNIT III

Hobbies, interests and daily routine	**12 Hours**
Grammaire – Irregular verbs – Reflexive verbs - Future procheCommunication – Talking about hobbies and interests.	

UNIT IV

Vocabulary of places and transport	**12 Hours**
Grammaire – Pertinent verbs, adjective demonstrative, past tense, propositionsCommunication – Narrating an incident or story.	

UNIT V

Vocabulary of food, services, money	**12 Hours**
Grammaire – Negation, Verbs – acheter, manger, payer, articles partitifs Communication – Accept and refuse an invitation, situation in a restaurant.	

References:	**60 Hours**
1) Grammaire Progressive du Français, CLÉ International, 2010.	
2) Saison 1, Marie-Noëlle Cocton et al, Didier, 2014.	
3) Preparation à l'examen du DELF A1 – Hachette	

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U18GEI2201	GERMAN LEVEL I (Comman to all)	L	T	P	J	C
		2	0	2	0	3

Course Objectives:

- To train the students to learn basic German.
- To teach them to learn basic grammar and vocabulary.
- To train them to converse in German in day-to-day scenarios.

Course Outcomes:

After the course, the students will be able to:

CO1: to help students acquire familiarity in the German alphabet & basic vocabulary

CO2: listen and identify individual sounds of German.

CO3: use basic sounds and words while speaking.

- read and understand simple advertisements, brochures and invitations.
- understand and use basic grammar and appropriate vocabulary in completing language tasks.

Assessment Methods:

Direct
1. Continuous Assessment of Skills 2. Assignment 3. Written Test 4. End Semester Examination
Indirect
1. Course-end survey

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CO/PO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
COs	**Programme Outcomes (POs)**											**PSO**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1									**S**	**S**		**S**		
CO2									**S**	**S**		**S**		
CO3									**S**	**S**		**S**		

UNIT – 1

Introduction to Germany and its regions –German basic phrases, alphabets, numbers,countries and nationality	**12 Hours**
Grammaire – Verbs – sein, haben, definite and indefinite articlesCommunication – Greetings, Self-Introduction	

UNIT II

Basic vocabulary, colours, months and days	**12 Hours**
Grammaire - Verbes - Conjugation: Present tense (regular verbs) – Adjective possesive Communication – Talk about family and friends, date, time etc.	

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UNIT III

Hobbies, interests and daily routine	**12 Hours**
Grammaire – Irregular verbs Communication – Talking about hobbies and interests.	

UNIT IV

Vocabulary of places and transport	**12 Hours**
Grammaire – Cases, adjective demonstrative, past tense, propositions Communication – Narrating incident or story	

UNIT V **12Hours**

Vocabulary of food, services, money	**12 Hours**
Grammaire – Negation, Verbs – kaufen, essen, bezahlen Communication – Accept and refuse an invitation, situation in a restaurant	

L: 60 T: 0 Total: 60 periods

References:

1. Studio d - Deutsch alsFremdsprache - Grundstufe - A1.
2. Fit Fur Goethe-Zertifikat A1 (Start Deutsch 1)
3. Mit ErfogZum Goethe-Zertifikat A1

Software:

All internet tools.

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U18HII2201	HINDI LEVEL I	L	T	P	J	C
		2	0	2	0	3

Course Objectives

1. To help the students learn Hindi Scripts Vowels and Consonants.
2. To help the students learn basic Hindi grammar.
3. To make the students understand the way the Language is to be spoken.
4. To ensure that the students are empowered with linguistic knowledge.
5. To make the students acquire basic conversational skills.

Course Outcomes

1. Recognize and write Hindi alphabets.
2. Students will get to know the usage of words.
3. Students are confident enough to speak Hindi.
   Students sound grammatically correct and confident.

Assessment Methods:

Direct
1. Continuous Assessment of Skills 2. Assignment 3. Written Test 4. End Semester Examination
Indirect
1. Course-end survey

CO/PO Mapping:

	CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak													
COs	**Programme Outcomes (POs)**												**PSO**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O 1**	**PS O 2**
CO1									**S**	**S**		**S**		
CO2									**S**	**S**		**S**		
CO3									**S**	**S**		**S**		

UNIT – 1

Introduction to Hindi language - Recognize and write Alphabets – Identify basic sentence structure – Greet each other – Ask questions - Days of the week – Numbers – Expressing time.

Listening: Listening to Greetings, Numbers and Time.

Speaking: Self Introduction

UNIT – 2

Identify what is there and what is not there – Use postpositions(mein, par, ke paasetc.) – Use of singular/plural – Masculine/Fminine – Name and identify relatives –Express possession with kinship terms (ka/ke/kii) – parts of body

Listening: Listening for specific information, Family members, Parts of body

Speaking: Introducing one's family,

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UNIT – 3

Vowels, consonants and conjoint letters and related vocabulary – Fruits, Vegetables, Food and Groceries – Use possessive pronouns – use interrogativepronouns (kaun, kiskaa,kiskii,kiske,kahaan se) – Present habitual actions – pasthabitual actions – today, tomorrow ,yesterday , day before yesterday, day aftertomorrow (aaj/kal/parson)

Listening: Simple conversation between Shop keeper and customer

Speaking: Names of fruits and vegetables , Express one's daily routine

UNIT – 4

Create and follow a simple recipe – Use indirect verbs with nouns (isko, usko,..etc.) – express needs Ask about and express wishes and preferences – Useinfinitive – use comparative and superlative degree of adjectives – Use more interrogative words – Explain about future plans – simple future actions

Listening: Listening to a simple recipe

Speaking: Express your needs and wishes , future plans

UNIT – 5

Learn about some festivals like Diwali, Pongal, Holli etc. – Learn some shortstories

Listening: Short stories

Speaking: Making small stories , Describe your favorite festival.

Reference

1.Hindi Prachar Vahini-1, Prathmic Exam. (For Basics and Grammar)

2. Hindi Prachar Vahini-2 Madhyama Book (For Spoken Hindi) D.B.HindiPrachar Sabha, T.Nagar, Chennai.

3. Sabari Hindi Speaking Course, For Spoken. Sabari Book House, Salem

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U18JAI2201	JAPANESE LEVEL I	L	T	P	J	C
		2	0	2	0	3

Course Objectives:

1. To enable students, achieve a basic exposure on Japan, Japanese language andculture.
2. To make students familiar with the Japanese cultural facets and social etiquettes.
3. To make the students acquire basic conversational skills.
4. To help students learn the Japanese scripts viz. hiragana and a few basic kanji.
5. To help students learn the basic Japanese grammar.

Course Outcomes:

After the course, the students will be able to:

CO1: Recognize and write Japanese alphabet.

CO2: Speak using basic sounds of the Japanese language.

CO3: Apply appropriate vocabulary and grammar needed for simple conversation in Japanese language. Comprehend the simple day to day conversation and give correct meaning.

Assessment Methods:

Direct
1. Continuous Assessment of Skills 2. Assignment 3. Written Test 4. End Semester Examination
Indirect
1. Course-end survey

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CO/PO Mapping:

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak														
COs	**Programme Outcomes (POs)**												**PSO**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1									**S**	**S**		**S**		
CO2									**S**	**S**		**S**		
CO3									**S**	**S**		**S**		

UNIT - 1	**12 Hours**
Japan: Land and culture - Introduction to Japanese language – Greetings – Seasons - Days of the week - Months of the year – Dates of the month - Self introduction – Numbers (Upto 99,999) – Expressing time – Conversation audio and video. **Listening:** Listening to Greetings - Listening for Specific Information: Numbers, Time. **Speaking: Self-Introduction**	

UNIT - 2	**12 Hours**
Family relationships - Colours - Parts of body - Profession - Directions - Time expressions (today, tomorrow, yesterday, day before, day after) - Japanese housing and living style - Food and transport (vocabulary) - Stationery, fruits and vegetables. **Listening:** Listening for Specific Information**:** Directions, Family Members, Parts of body **Speaking:** Introducing one's family**.**	

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UNIT - 3	12 Hours

Hiragana Chart 1 - vowels and consonants and related vocabulary – Hiragana Charts 2&3, double consonants, vowel elongation and related vocabulary – Introduction to Kanji – BasicVocabulary – Basic Conversational Phrases.

Listening: Listening to Japanese Alphabet Pronunciation, Simple Conversation.

Speaking: Pair Activity (Day to day situational conversation)

UNIT - 4	12 Hours

Katakana script and related vocabulary – Basic kanjis: naka, ue, shita, kawa , yama , numbers (1-10, 100, 1000, 10,000 and yen) , person, man, woman, child, tree , book , hidari, migi, kuchi , 4 directions - Usage of particles wa, no, mo and ka and exercises - Usage of kore, sore, are, kono, sono, ano, arimasu and imasu - Particles – ni (location) and ga , donata and dare - Particles ni (time), kara, made , ne , koko, soko, asoko and doko - Directions : kochira, sochira, achira and dochira , associated vocabulary (mae, ushiro, ue, shita, tonari, soba, etc.)

Listening: Listening to conversation with related particles

Speaking: Individual Activity (Constructing simple sentences using particles)

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UNIT - 5	12 Hours
Introduction to Verbs - Verbs –Past tense, negative - i-ending and na-ending adjectives introduction - ~masen ka, mashou - Usage of particles de, e, o, to, ga(but) and exercises - Adjectives (present/past – affirmative and negative) – Counters - ~te form **Listening:** Listening to different counters, simple conversations with verbs and adjectives. **Speaking:** Pair Activity (Explaining one's daily routine by using appropriate particles and verbs)	

L: 60 T: 0 Total: 60 periods

Reference:

1. Japanese for dummies. Wiley publishing Co.Inc., USA.
2. *Japanese for Everyone: Elementary Main Textbook1-1*, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
3. *Japanese for Everyone: Elementary Main Textbook 1-2*, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
4. www.japaneselifestyle.com
5. www.learn-japanese.info/
6. www.kanjisite.com/
7. www.learn-hiragana-katakana.com/typing-hiragana-characters/

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MINOR SPECIALISATION

MINOR SPECIALISATION IN 3D PRINTING

U18MCR0001	FUNDAMENTALS OF 3D PRINTING	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to	
CO7:	Discuss the basics concepts of 3D printing technology
CO8:	Explain the basics of computer graphics
CO9:	Develop CAD models for 3D printing
CO10	Select a specific material for the given application
CO11	Explain various method for designing and modeling for industrial applications
CO12	Import and Export CAD data and generate .stl file

Pre-requisite

-

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2	S	W										
CO3	M	S	M		S							
CO4	M	S	M									
CO5	M	S	M		S				M			
CO6	M				S				M			

Course Assessment methods:

DIRECT	INDIRECT
Internal test I Internal test II End semester Examination. Assignment	Course end survey

INTRODUCTION	**8 Hours**
Introduction, Design considerations, Principles of 3D printing, Additive v/s Conventional Manufacturing processes, components – nozzle, plate, feeder heater	
FUNDAMENTALS OF COMPUTER GRAPHICS	**7 Hours**
Computer Graphics – Co-Ordinate Systems- 2D And 3D Transformations Homogeneous Coordinates – Line Drawing -Clipping- Viewing Transformation.	
CAD	**11 Hours**
Definitions, evolution, Product design and rapid product development, conceptual design, detail design, prototyping, 3D solid modeling and slicing software and their role in 3D printing, CAD Data formats, Data translation, Data loss, STL format, creation of STL file.	
PRINTING MATERIALS	**10 Hours**

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Materials - Plastics, Metals, Ceramics, Carbon fiber, Nitinol, Biological Tissues, Hydrogels, Graphene; Material Selection, Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties, Support Materials.

INDUSTRIAL APPLICATIONS **9 Hours**

Product Models, manufacturing – Printed electronics, Biopolymers, Packaging, Healthcare, Food processing industry, Medical, Biotechnology, Displays; Future trends.

Theory: 45 Hours **Practical: 15 Hours.** **Total Hours: 60**

REFERENCE BOOKS

1. Hod Lipson, Melba Kurman, "Fabricated the new world of 3D printing", John Wiley & sons, 2013.
2. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
3. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011
5. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
6. Additive Manufacturing of Metals: Fundamentals and Testing of 3D and 4D Printing by Hisham Abdel-Aal

LIST OF EXPERIMENTS

1. 3D Modelling of a single component.
2. Assembly of CAD modelled Components.
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.

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U18MCR0002	ADDITIVE MANUFACTURING PROCESSES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Understand the fundamentals of additive manufacturing
CO2:	Describe the operating principles of liquid based additive manufacturing process.
CO3:	Describe the operating principles of solid based additive manufacturing process.
CO4:	Explain the concepts of powder based additive manufacturing process.
CO5:	Describe the principles of binder and LOM additive manufacturing process.
CO6:	Understand the various types of post-processing in additive manufacturing process.

Pre-requisite

U18MCR0001 - Fundamentals of 3D Printing

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	W										
CO2	S	W										
CO3	M	S	M									
CO4	M	S	M									
CO5	M	S	M									
CO6	M	M	W									

Course Assessment methods:

DIRECT	INDIRECT
Internal test I Internal test II End semester Examination. Assignment	Course end survey

INTRODUCTION	**7 Hours**
Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes.	
LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS	**10 Hours**
Photo polymerization: Stereolithography Apparatus (SLA) - Materials -Process –Advantages Limitations-Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM) - Process-Materials - Applications and Limitations.	
POWDER BASED ADDITIVE MANUFACTURING SYSTEMS	**9 Hours**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism – Process Parameters – Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS) - Process -Material Delivery - Process Parameters -Materials - Benefits -	

Applications.	
BINDER AND LAMINATED OBJECT MANUFACTURING SYSTEMS	**10 Hours**
Binder Jetting: Three-Dimensional Printing - Materials -Process - Benefits and Limitations. Material Jetting: MultiJet Modeling- Materials- Process- Benefits. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation.	
POST-PROCESSING IN ADDITIVE MANUFACTURING	**9 Hours**
Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.	
	Total Hours: 45

REFERENCE BOOKS

1. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2009.
2. Ali Kamrani, Emad Abouel Nasr, Rapid Prototyping Theory and Practice (Manufacturing Systems Engineering Series), Springer, 2006
3. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011
5. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.

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U18MCR0003	MECHATRONICS IN 3D PRINTING	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Understand the fundamentals of mechatronics and its importance in 3D Printing
CO2:	Describe the operating principles of 3D Printing actuators and Controllers
CO3:	Describe the mechanical components in 3D Printing
CO4:	Explain the different sensors used in 3D Printing
CO5:	Classify the communication protocols.

Pre-requisite

U18MCR0002 - Additive Manufacturing Processes

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M										
CO2	S	W										
CO3	M	S	M									
CO4	M	S	M		M							
CO5	M	S	M		M							

Course Assessment methods:

DIRECT	INDIRECT
Internal test I Internal test II End semester Examination. Assignment	Course end survey

INTRODUCTION	**7 Hours**
Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – 3 pillars of 3D printing, resolution, accuracy and repeatability	
ACTUATORS AND CONTROLLERS	**10 Hours**
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages, motor drivers, Controller board, Screens and user interfaces.	
MECHANICAL COMPONENTS IN 3D PRINTING	**9 Hours**
Pulley, Timing belt, lead screw, Bearing, Guide ways, Coupling, Spring, Extruder, Cooling fan, Gears and types.	
SENSORS	**10 Hours**
Principles of working - Construction-characteristics and limitations of Thermal Sensor or Temperature Sensor, Filament Sensor, Proximity sensor or bed levelling sensors, Thermistor, Thermocouple, RTD, Encoders.	
INDUSTRIAL COMMUNICATION PROTOCOLS	**9 Hours**
Definition of protocol, Introduction to Open System Interconnection (OSI) model, Communication standard (RS232, RS485), Modbus (ASCII & RTU), Introduction to third party interface, concept of OPC (Object linking and embedding for Process Control), IPP (Internet printing protocol) – Printing from mobile devices.	
Theory: 45 Hours **Practical: 15 Hours.** **Total Hours: 60**	

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REFERENCE BOOKS

1. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2009.
2. Ali Kamrani, Emad Abouel Nasr, Rapid Prototyping Theory and Practice (Manufacturing Systems Engineering Series), Springer, 2006
3. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
4. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011
5. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
6. Richard Zurawski, "Industrial Communication Technology Handbook", CRC Press, 2nd Edition, 2017.

List of experiments:

1. Temperature measurement using Arduino.
2. Data visualization with Arduino
3. Position measurement.
4. Stepper motor control using Arduino.
5. Servo motor control using Arduino.
6. UART and I2C Communication protocol

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U18MCR0004	3D PRINTING LABORATORY	L	T	P	J	C
		0	0	2	0	1

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Investigate on file Import and model configuration.
CO2:	Plan on setting orientation, slicing and tool path generation.
CO3:	Create components using a 3D printer.
CO4:	Perform tensile and compression testing on part.

Pre-requisite

U18MCR0003 - Mechatronics in 3D Printing

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	Programme Outcomes (Pos)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S								S	S		
CO2	S								S	S		
CO3	S								S	S		
CO4	S								S	S		

Course Assessment methods:

DIRECT	INDIRECT
Work book. Model Exam	Course end survey

LIST OF EXPERIMENTS

1. Importing and Configuring Model
2. Build option and orientation setting.
3. Slicing setting and Correction
4. Support and Tool path Generation.
5. Build a component without support material
6. Build a component with support material.
7. Mechanical testing (Tensile and Compression)

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U18MCR0005	PROJECT	L	T	P	J	C
		0	0	0	6	3

Course Outcomes

After successful completion of this course, the students should be able to	
CO1:	Design, analyze, realize / simulate a physical system by using the technology they learnt during the program.
CO2:	Integrate various systems into one Mechatronics product.
CO3:	Work in a team with confined time duration.
CO4:	Disseminate his work both in oral and written format.

Pre-requisite

U18MCR0001-Fundamental of 3D printing

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	S		M	M				S
CO2	S	S	S	S	S	M	M	M				S
CO3									S			
CO4										S	S	

Course Assessment methods:

DIRECT	INDIRECT
6. Interdisciplinary work 7. Innovation 8. Working model/ simulation result 9. Report with good referencing. 10. End Semester Viva Voice	1.Course end survey

Students in the form of a group, not exceeding 4 members in a group to carry out their main project. It should be a 3D printing project. However, special considerations can be given for interdisciplinary measurement and computer-based simulation projects. This exception should be recorded and approved by the department committee. Management-related projects will not be allowed. The interdisciplinary projects will carry more weightage.

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MINOR SPECIALIZATION IN ROBOTICS

U18MCR0008	FUNDAMENTALS OF ROBOTICS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO6: Discuss the history, classification, Application, and limitations of robotics

CO7: Explain the basics elements of robots

CO8: Explain the different types of actuators used in robots

CO9: Select a specific sensor for the given robotic application

CO10: Explain the basic concepts of computer graphics

CO11: Develop 3D CAD model components and assemble them using a 3D modeling software

Pre-requisite

-

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	M													
CO2	S	W	W											
CO3	S	M			W							M		
CO4	S	M	M	W	M	W						M		
CO5	S				M				M					
CO6	S		M		S					M		M		

Course Assessment methods:

Direct	Indirect
Internal test I Internal test II End semester Examination. Assignment	Course end survey

FOUNDATIONS FOR ROBOTICS	**4 Hours**

History of Robotics – Various definitions of a robot – Laws of Robot – General classification of robots – Application and limitations.

SIMPLE ELEMENTS OF ROBOTS	**6 Hours**

Links – Types of links – Degrees of freedom – Joints – Gears – Belt – Lead screw – Pulleys

ROBOT ACTUATORS	**8 Hours**

Actuators and the types of actuators in a robot – Mechanical actuators – Hydraulic and Pneumatic actuators – Linear actuators – Drivers – DC, Stepper motor, Servo motor.

SENSORS	**8 Hours**
Sensor's definition – Types of sensors – Proximity – Pressure – temperature – Vision – LIDAR – GPS – Encoder.	
CAD FOR ROBOTICS	**4 Hours**
Introduction – Understanding Computer graphics – Coordinate systems – 2D and 3D transformations – Line Drawing and Viewing Transformations.	
Theory: 30 Hours	**Practical: 15 Hours.** **Total Hours: 45**

REFERENCES:

8. Saeed B Niku, 'Introduction to Robotics', 2nd edition, Prentice Hall of India, 2018.
9. Bhandari V B., "Design of Machine Elements", 5th edition, Tata McGraw Hill Publication Co., 2020.
10. Janardanan, E.G, "Special Electrical Machines", PHI Learning, 2014.
11. Patra Nabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi,2010.
12. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 2009
13. Fu K S, Gonzalez R C, Lee C S G, "Robotics, control, sensing, Vision and Intelligence", McGraw Hill International, 1987

LIST OF EXPERIMENTS

1. 3D Modelling of a single robotic component.
2. Assembly of robotic components into a complete Robot
3. Exercise on CAD Data Exchange.

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U18MCR0009	INTRODUCTION TO SINGLE-BOARD MICROCONTROLLER AND COMPUTER	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Create sketches and use libraries inside the Integrated Development Environment

CO2: Measure physical parameters using sensors and use various communication protocols

CO3: Apply OS to the single-board computer platform

CO4: Use python programming to interface GPIO and sensors

CO5: Implement communication protocols for wired and wireless communication

CO6: Design robots by interfacing with motors and cameras

Pre-requisite

-

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2
CO1	M		M											
CO2	M		S	M	S									
CO3	W		M											
CO4	M		S		S									
CO5	W	M	S		S									
CO6	S	S	M	M	S									

Course Assessment methods:

Direct	Indirect
Internal test I Internal test II End semester Examination. Assignment	Course end survey

INTRODUCTION TO SINGLE-BOARD MICROCONTROLLER	6 Hours

Single board microcontroller Platform, Integrated development environment (IDE), Programs, libraries, programming language, Datatypes, Loops, functions, and structures

SENSING AND COMMUNICATING	8 Hours

Sensors, Digital and Analog signals, Interfacing with Temperature sensors, Humidity sensors, Proximity sensors, Accelerometers, and Gyro, UART, SPI, and I2C Communication protocols

INTRODUCTION TO SINGLE-BOARD COMPUTER(SBC)	4 Hours

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SBC board components, versions, Install OS distribution, set up and configure OS.

PROGRAMMING THE SINGLE-BOARD COMPUTER(SBC)	**6 Hours**

Introduction to python programming, python IDE, strings, functions, Loops, Lists, NumPy, GUI, GPIO pins, sensor interface, Communication Protocols

INTERFACE MOTORS AND CAMERA	**6 Hours**

DC, Servo, stepper motor, Motor Drivers, Motor shields, Camera Interface, Basic image processing, Mobile robot control

Theory: 30 Hours **Practical: 15 Hours.** **Total Hours: 45**

REFERENCES:

1. Simon Monk, "Programming Arduino: Getting Started with Sketches" , 2nd edition, Prentice Hall of India, 2016.
2. John Nussey, "Arduino for Dummies", 1st Edition, John Wiley & sons,2013.
3. Simon Monk, "Programming the Raspberry Pi, Getting Started with Python, 3rd Edition", Tata McGraw-Hill, 2003.
4. Tim Cox, "Raspberry Pi Cookbook for Python Programmers", PACKT, 2014.

LIST OF EXPERIMENTS

1. Study about basic interfacing of various actuators
2. General hardware interfacing (LED, switch, seven-segment display, Relay, LCD, buzzer)
3. Interfacing single board controller with different sensors (Touch sensor, Temperature sensor, LDR, Humidity sensor, Moisture sensor, Accelerometer, IR sensor, Proximity sensor)
4. Single Board Computer OS installation and setup
5. Motor and sensor Interface with Single Board Computer
6. Simple mobile robot control

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U18MCR0010	AUTONOMOUS MOBILE ROBOT	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1:	Explain different types of mobile robot locomotion	K2
CO2:	Apply mobile robot kinematics and constraints	K2
CO3:	Choose sensors for the perception of mobile robots.	K2
CO4:	Implement robot localization techniques	K3
CO5:	Explain planning and navigation in robotics	K2
CO6:	Simulate a robot in robot operating system	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S													
CO2	S	M	M		M									
CO3	S				M									
CO4	S				M									
CO5	S													
CO6	S				M									

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc (as applicable) 3. End Semester Examination	1. Course end survey

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LOCOMOTION	**6 Hours**
Introduction to Robotics – key issues in robot locomotion – Types of Locomotion -legged robots – wheeled mobile robots – aerial mobile robots – stability - robot maneuverability – controllability	
MOBILE ROBOT KINEMATICS	**8 Hours**
Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, simulation of mobile robots	
ROBOT PERCEPTION	**5 Hours**
Sensors for mobile robots -global positioning system (GPS), Ultrasonic sensor, vision-based sensors, uncertainty in sensing.	
MOBILE ROBOT LOCALIZATION AND PATH PLANNING	**6 Hours**
Introduction to localization – challenges in localization – localization and navigation – belief representation – A* Algorithm and Voronoi Diagram	
ROBOT OPERATING SYSTEM	**5 Hours**
Installing ROS, Creating workspace, Introduction to Turtlesim, topics and messages, obstacle avoidance behavior	
Theory: 30 Hours **Practical: 15 Hours.** **Total Hours: 45**	
REFERENCES:	
1. Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, "Introduction to autonomous mobile robots", Second Edition, MIT Press, 2011.	
2. Howie Choset, Kevin M. Lynch, Seth Hutchinson , George A. Kantor , Wolfram Burgard , Lydia E. Kavraki, Sebastian Thrun , "Principles of Robot Motion: Theory, Algorithms, and Implementations", A Bradford Book, 2005.	
3. Gregory Dudek and Michael Jenkin, "Computational Principles of Mobile Robotics", Second Edition, Cambridge University Press, 2010.	
4. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.	
5. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006.	
LIST OF EXPERIMENTS:	
1. ROS operating system installation and configuration.	
2. Simulation of mobile robot in ROS.	
3. Writing and verifying a Program for point-to-point operations for mobile robots	
4. Obstacle Avoidance of a mobile robot with Ultrasonic Sensor	
5. Tilt sensing for an autonomous mobile robot	
6. Line following robot	

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U18MCR0011	INDUSTRIAL ROBOTICS	L	T	P	J	C
		2	0	2	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1:	Explain the robotic terminologies for various configurations	K2
CO2:	Select an appropriate gripper for a given application and use a gripper for pick and place application	K3
CO3:	Calculate the forward kinematics, inverse kinematics and Jacobian for a serial robot	K3
CO4:	Explain the various application of industrial robots	K3
CO5:	Describe communication protocols used in robot	K2
CO6:	Explain and practice various programming techniques used in industrial robots	K3

Pre-requisite

Nil

CO/PO Mapping

(S/M/W indicates strength of correlation) S – Strong, M – Medium, W – Weak

Cos	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	S													
CO2	S			W					M	M				
CO3	S	M	M		M				M	M				
CO4	S	M	M											
CO5	M													
CO6					S				M	M				

Course Assessment methods:

Direct	Indirect
1. Continuous Assessment Test I, II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc. (as applicable) 3. End Semester Examination	Course end survey

INTRODUCTION 4 Hours

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace.

KINEMATICS OF ROBOTS 10 Hours

Introduction - Matrix Representation - Homogeneous transformation matrices – Forward and Inverse kinematics Equations: Position and Orientation -Denavit- Hardenberg Representation of forward kinematics equations of robots- Degeneracy and Dexterity.

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APPLICATION OF ROBOTS	**4 Hours**
Robot Application in Manufacturing: Material Transfer – Material handling, loading and unloading- Processing – spot and continuous arc welding & spray painting – Assembly and Inspection.	
SOFTWARE INTERFACES	**4 Hours**
Software interfaces: Low level interfaces, IO digital signals, Fieldbuses – Data protocols and connections	
END EFFECTORS	**4 Hours**
End effectors and Different types of grippers, vacuum and other methods of gripping - Gripper's force analysis-Gripper Design-Simple problems	
ROBOT PROGRAMMING	**4 Hours**
Robot programming: Introduction; On-line programming: Manual input, lead through programming, teach pendant programming; Off-line programming languages, Simulation.	
Theory: 30 Hrs. **Practical: 15Hrs.**	**Total Hours: 45**
REFERENCES:	

1. Saeed B Niku, 'Introduction to Robotics: Analysis, Control, Applications', 3rd Edition, Wiley, 2019.
2. Mikell P Groover, "Industrial Robots - Technology, Programming and Applications", 2nd Edition, McGraw Hill, New York, 2012.
3. Norberto Pires, 'Industrial Robots programming: Building Applications for the Factories of the Future', 1st edition, Springer, 2012
4. Saha S K, 'Introduction to Robotics', 2nd Edition, Tata McGraw Hill Education Pvt. Ltd, 2014.
5. Spong and Vidhyasagar, 'Robot Dynamics and Control', John Wiley and sons, 2008.
6. Roobert Schilling, 'Fundamentals of Robotics: Analysis and Control, 1st Edition, Pearson India, 2015

LIST OF EXPERIMENTS:

1. Study of different types of robots based on configuration and application.
2. Study of different type of robotics simulation software.
3. Offline programming of an Industrial robot using a Robotics simulation Software
4. Setup and program a robot with object profile tracking using a Robotics simulation Software
5. Develop a trajectory planning for a robot using a simulation software.
6. Setup and program an Industrial Robot with a pneumatic vacuum gripper for a simple pick and place operation

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U18MCR0012	CAPSTONE PROJECT	L	T	P	J	C
		0	0	0	0	6

Course Outcomes

After successful completion of this course, the students should be able to	
CO1	Design, analyze, realize / simulate a physical system by using the technology they learnt during the program.
CO2	Integrate various systems into one Mechatronics product.
CO3	Work in a team with confined time duration.
CO4	Disseminate his work both in oral and written format.

Pre-requisite

-

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	S		M	M				S
CO2	S	S	S	S	S	M	M	M				S
CO3									S			
CO4										S	S	

Course Assessment methods:

DIRECT	INDIRECT
11. Interdisciplinary work 12. Innovation 13. Working model/ simulation result 14. Report with good referencing. 15. End Semester Viva Voice	1.Course end survey
Students in the form of a group, not exceeding 4 members in a group to carry out their main project. However, special considerations can be given for interdisciplinary measurement and computer-based simulation projects. This exception should be recorded and approved by the department committee. Management-related projects will not be allowed. The interdisciplinary projects will carry more weightage.	

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NPTEL COURSE

U18MCE0021	SURFACE ENGINEERING OF NANOMATERIALS	L	T	P	J	C
		2	0	0	0	2

Course Outcomes

After successful completion of this course, the students should be able to

CO12: Discuss the basics concepts of Tribology

CO13: Explain the basics of conventional surface engineering and Surface modification Methods

CO14: Discuss about Synthesis, Processing and Characterization of nanostructured coatings

CO15: Explain Need for advanced methods for surface and coating testing

CO16: Discuss about Microencapsulation and Thin film for Surface Engineering of Nanomaterials

CO17: Current trends in surface modification of nanomaterials

Pre-requisite -

Course Assessment methods:

Direct	Indirect
Final Examination Assignment	Weekly Feedback Survey

INTRODUCTION TO TRIBOLOGY	**3 Hours**

Tribology & its classification, Friction tribology, Wear & corrosion, Lubrication, Effect of tribology on surface of nanomaterials.

CONVENTIONAL SURFACE ENGINEERING AND SURFACE MODIFICATION METHODS	**5 Hours**

Conventional surface engineering, Types of surface modifications, Physical modifications, Chemical modifications, Applications of surface engineering towards nanomaterials. Deposition and surface modification methods, Physical vapor deposition, Chemical vapor deposition, Advanced surface modification practices, Advantages of deposition for surface modification.

SYNTHESIS, PROCESSING AND CHARACTERIZATION OF NANO-STRUCTURED COATINGS	**3 Hours**

Synthesis, processing and characterization of nano-structured coatings, Functional coatings, Advanced coating practices, Characterization of nano-coatings, Applications of nano-coatings.

NEED FOR ADVANCED METHODS FOR SURFACE AND COATING TESTING	**3 Hours**

Need of advanced methods for surface and coating testing, Size dependency in nanostructures of nano coatings, Size effect in electrochemical properties of nanostructured coatings, Size effect in mechanical properties of nanostructured coatings, Size effect in physical and other properties of nanostructured coatings.

MICROENCAPSULATION AND THIN FILM FOR SURFACE ENGINEERING	**5 Hours**

Microencapsulation: Processes, Microencapsulation: Kinetics of release, Plating of nanocomposite coatings, Advantages of microencapsulation over other conventional methods. Thin films for surface engineering of nanomaterials, Sputtering techniques, Evaporation processes, thin film deposition through gas phase techniques, Liquid phase techniques.

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CURRENT TRENDS IN SURFACE MODIFICATION OF NANOMATERIALS	**3 Hours**
Current trends in surface modification of nanomaterials, Modified Nanomaterials: In-use for consumer products, Main problems in synthesis of modified nanomaterials.	
Theory: 22 Hours	**Total Hours: 22**
REFERENCES:	
14. Introduction to Tribology by Bharat Bhusan, John Wiley & Sons, USA	
15. Handbook of thin film deposition processes and techniques Edited by Krishna Seshan, William Andrew Publishing Norwich, New York, U.S.A.	
16. Nanomaterials and Surface Engineering, Edited by Jamal Takadoum, John Wiley & Sons, Inc., USA.	
17. Nanocoatings: Size Effect in Nanostructured Films by Mahmood Aliofkhazrae, Springer-Verlag, USA	

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U18MCE0022	FUNDAMENTALS OF AUTOMOTIVE SYSTEMS	L	T	P	J
		3	0	0	0

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Acquire fundamental knowledge of the various systems of an Automobile,

CO2: Associate the functions of each system with its design and layout

CO3: Depict the various systems using simple schematics

CO4: Apply concepts learnt in core undergraduate courses to synthesize mathematical models of the various systems

CO5: Components of Suspension System, Dependent and Independent Suspension, Introduction to Electric and Hybrid Powertrain, Tyres

CO6: Power Steering System, Wheel Alignment, Introduction to Suspension System

Pre-requisite

-

Course Assessment methods:

Direct	Indirect
Final Examination Assignments -12	Weekly Feedback Survey

IC ENGINES AND TWO STROKE ENGINE	**6 Hours**

Classification of Internal Combustion Engines, Piston, Crankshaft, Cylinder Head, Valve Assembly, Engine Parameter Definitions, Four Stroke Engines and their Operating Strokes, Two Stroke Engine, Engine Cycles, Air Standard Cycles, Otto Cycle, Diesel Cycle, Engine Performance

ENGINE PERFORMANCE AND FUEL INTRODUCTION SYSTEM	**5 Hours**

Indicated Mean Effective Pressure, Supercharging, Turbocharger, Combustion in SIEngines, Knocking in SI Engine, Factors affecting Knocking, Octane Number, Stages of

Combustion in CI Engines, Knocking in CI Engines, Cetane Number, Mixture Preparation in SI Engines, Carburetor, Port Injection, Gasoline Direct Injection, Diesel Direct Injection,Carburetor Analysis, Choke Valve

ENGINE EMISSION AND AUTOMOTIVE CLUTCH, POWER TRAIN ANALYSIS	**6 Hours**

Clutch Construction, Clutch Operation, Clutch Actuation, Gearbox, Manual Transmission, Synchronizer, Tractive Effort from Powertrain, Analysis of Forces Acting on the Vehicle during Drive, Maximum Tractive Effort, Front Wheel Drive, Rear Wheel Drive, Gradeability, Transmission Matching, Gear Ratio Calculation, Components of a Brake System, Drum Brake, Hydraulic Brake System, Brake Fluid, Brake Lining

AIR AND ANTILOCK BRAKE SYSTEM, BRAKING ANALYSIS, MANUAL STEERING SYSTEMS	**6 Hours**

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Air Brake, Treadle Valve, Compressed Air, Relay Valve, Quick Release Valve, S cam Brake, Slack Adjuster, Parking Brake, Antilock Brake System, Friction Ellipse, Consequences of Wheel Lock, ABS Components, Configurations and Operation Methodologies, Forces Acting on the Vehicle During Braking, Ideal Brake Force Distribution, Wheel Lock Analysis, Components of a Steering System, Pitman Arm Type Steering, Rack and Pinion Steering

STEERING ANALYSIS, SUSPENSION AND SHOCK ABSORBERS, ELECTRIC AND HYBRID POWERTRAIN	**7 Hours**

Power Steering, Hydraulic Power Steering, Electro Hydraulic Power Steering, Electric Power Steering, Kinematic Bicycle Model, Wheel Alignment, Camber, Caster, Toe, Wheel Balancing, Tyre Rotation, Interpretation of Tyre Wear, Functions of a Suspension System, Springs, Shock Absorber, Passive Suspension, Semi Active Suspension, Active Suspension, Independent Suspension, Dependent Suspension, Solid Axle and Beam Axle Suspension, Quarter Car Model, Ride Analysis, Classification of Electrified Powertrain, Performance Analysis

Theory: 30 Hours **Total Hours: 30**

REFERENCES:

1. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.
2. R. Stone and J. K. Ball, Automotive Engineering Fundamentals, SAE International, 2004
3. T. K. Garrett, K. Newton, and W. Steeds, The Motor Vehicle, 13th Edition, SAE International, 2001.
4. D. B. Astow, G. Howard and J. P. Whitehead, Car Suspension and Handling, 4th Edition, SAE International, 2004.
5. R. Limpert, Brake Design and Safety, SAE International, 1992.
6. V. Ganesan, Internal Combustion Engines, 3rd Edition, Tata McGraw Hill, 2007.
7. M. Ehsani, Y. Gao and A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition, CRC Press, 2010.

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U18MCE0023	SURFACE ENGINEERING OF NANOMATERIALS	L	T	P	J	C
		2	0	0	0	2

Course Outcomes

After successful completion of this course, the students should be able to

CO18: Discuss the basics concepts of Tribology

CO19: Explain the basics of conventional surface engineering and Surface modification Methods

CO20: Discuss about Synthesis, Processing and Characterization of nanostructured coatings

CO21: Explain Need for advanced methods for surface and coating testing

CO22: Discuss about Microencapsulation and Thin film for Surface Engineering of Nanomaterials

CO23: Current trends in surface modification of nanomaterials

Pre-requisite -

CO/PO Mapping

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2	S	W										
CO3	M	S	M		S							
CO4	M	S	M									
CO5	M	S	M		S				M			
CO6	M				S				M			

Course Assessment methods:

Direct	Indirect
Final Examination Assignment	Weekly Feedback Survey

INTRODUCTION TO TRIBOLOGY	**3 Hours**

Tribology & its classification, Friction tribology, Wear & corrosion, Lubrication, Effect of tribology on surface of nanomaterials.

CONVENTIONAL SURFACE ENGINEERING AND SURFACE MODIFICATION METHODS	**5 Hours**

Conventional surface engineering, Types of surface modifications, Physical modifications, Chemical modifications, Applications of surface engineering towards nanomaterials. Deposition and surface modification methods, Physical vapor deposition, Chemical vapor deposition, Advanced surface

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modification practices, Advantages of deposition for surface modification.	
SYNTHESIS, PROCESSING AND CHARACTERIZATION OF NANO-STRUCTURED COATINGS	**3 Hours**
Synthesis, processing and characterization of nano-structured coatings, Functional coatings, Advanced coating practices, Characterization of nano-coatings, Applications of nano-coatings.	
NEED FOR ADVANCED METHODS FOR SURFACE AND COATING TESTING	**3 Hours**
Need of advanced methods for surface and coating testing, Size dependency in nanostructures of nano coatings, Size effect in electrochemical properties of nanostructured coatings, Size effect in mechanical properties of nanostructured coatings, Size effect in physical and other properties of nanostructured coatings.	
MICROENCAPSULATION AND THIN FILM FOR SURFACE ENGINEERING	**5 Hours**
Microencapsulation: Processes, Microencapsulation: Kinetics of release, Plating of nanocomposite coatings, Advantages of microencapsulation over other conventional methods. Thin films for surface engineering of nanomaterials, Sputtering techniques, Evaporation processes, thin film deposition through gas phase techniques, Liquid phase techniques.	
CURRENT TRENDS IN SURFACE MODIFICATION OF NANOMATERIALS	**3 Hours**
Current trends in surface modification of nanomaterials, Modified Nanomaterials: In-use for consumer products, Main problems in synthesis of modified nanomaterials.	
Theory: 22 Hours	**Total Hours: 22**
REFERENCES:	
18. Introduction to Tribology by Bharat Bhusan, John Wiley & Sons, USA	
19. Handbook of thin film deposition processes and techniques Edited by Krishna Seshan, William Andrew Publishing Norwich, New York, U.S.A.	
20. Nanomaterials and Surface Engineering, Edited by Jamal Takadoum, John Wiley & Sons, Inc., USA.	
21. Nanocoatings: Size Effect in Nanostructured Films by Mahmood Aliofkhazrae, Springer-Verlag, USA	

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