KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE – 641 049

Department of Electronics and Instrumentation Engineering

REGULATIONS 2018A

(2021 Onwards)

I to VIII Semesters

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Department of Electronics and Instrumentation Engineering

VISION

The Department of Electronics and Instrumentation Engineering (EIE) envisions a holistic education that transforms the learners into responsible engineers which shall enable them to identify significant problems both in industry and society to arrive at creative and sustainable solutions through collaborative team efforts.

MISSION

The Department of Electronics and Instrumentation Engineering (EIE) aims to

- Implement modern andragogical approach in academics, innovative research initiatives and collaborative projects that shall ethically address the societal needs.
- Develop knowledge and skills required to excel in manufacturing, automation and allied industries on a global platform.
- Expand the knowledge for higher studies and get inspired for lifelong learning.

Program Educational Objectives (PEOs)

Graduates of B.E (Electronics and Instrumentation Engineering) will

PEO 1	Excel in technical and professional career with core competence in automation.
PEO 2	Possess the passion for professional development by continuous learning in allied Engineering and Management fields.
PEO 3	Engage in resolving industrial and social issues using contemporary tools.
PEO 4	Exhibit professionalism and ethical attitude towards resolving automation issues to society at large.

Program Outcomes (POs)

Graduates of B.E (Electronics and Instrumentation Engineering) will be able to:		
PO 1	***Engineering Knowledge***	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to solve complex engineering problems.
PO 2	***Problem Analysis***	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	***Design / Development of Solutions***	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	***Conduct Investigations of Complex Problems***	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	***Modern Tool Usage***	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	***The Engineer and Society***	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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PO 7	***Environment and Sustainability***	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	***Ethics***	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	***Individual and Team Work***	Function competently as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	***Communication***	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make decisive presentations, and give and receive impeccable instructions.
PO 11	***Project Management and Finance***	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	***Life-long Learning***	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological transformation.

Program Specific Outcomes (PSOs)

Graduates of B.E (Electronics and Instrumentation Engineering) will be able to:	
PSO 1	Develop, analyse and calibrate Instruments and electronic systems for various real world applications adhering to ISA ethical codes.
PSO 2	Integrate programmable logic controllers (PLC), distributed control systems (DCS) for manufacturing and processing systems and also gain proficiency in relevant software tools.

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The total minimum credits required for completing the B. E. Programme in Electronics & Instrumentation Engineering is **161 credits**

CREDIT REQUIREMENT (161) FOR THE VARIOUS COURSE CATEGORIES:

Course Category	Courses	No. of Credits	Weightage (%)
Basic Science (BS)	6	23	14.47
Engineering Science (ES)	9	27	16.98
Humanity and Science (HS)	3	11	6.91
Professional core (PC)	16	59	37.11
Professional Elective (PE)	5	18	11.32
Open elective (OE)	2	6	3.77
Project Work (PW)	2	15	9.43
Total	**43**	159	**100**

Professional core (PC) Subject distribution under different streams given for Minimum Credit requirement

Electronics	Instrumentation	Automation
Credits: 24	Credits: 17	Credits: 19
15.58%	11.04%	11.69 %
Foundation in Electrical and Electronics Engineering (4)	Sensors and Measurements (4)	Modelling and Analysis of Dynamic Systems (4)
Analog Electronics (4)	MEMS and Sensor Design (3)	Process Dynamics and Control (4)
Electronic Signal Conditioning (4)	Field Instrumentation (4)	Industrial Automation (4)
Digital Fundamentals and Microprocessor (4)	Ancillary support System (3)	Industrial Communication and networking (3)
Embedded Microcontrollers (4)	Analytical Instrumentation (3)	Advanced Control systems (4)
Digital Signal processing and Deep learning (4)		

Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total EIE**
Credit	21	22	21	24	24	19	16	12	159

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CURRICULUM

SEMESTER I										
S. No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	**Pre-requisite**
1	U18ENI1201	Fundamentals of Communication I	Embedded - Theory and Practical	HS	2	0	2	0	3	--
2	U18MAI1201	Linear Algebra and Calculus	Embedded - Theory and Practical	BS	3	0	2	0	4	--
3	U18 PHI1201	Engineering Physics	Embedded - Theory and Practical	BS	3	0	2	0	4	--
4	U18MEI1201	Engineering Graphics	Embedded - Theory and Practical	ES	2	0	2	0	3	--
5	U18CSI1202	Problem Solving and Programming Using C	Embedded - Theory and Practical	ES	2	0	2	0	3	--
6	U18INI1600	Engineering Clinics I	Embedded - Theory and Practical	ES	0	0	4	2	3	--
	U18TLR1001	Heritage of Tamils	Theory	HS	1	0	0	0	1	
Total Credits									**21**	
Total Contact Hours/week									**29**	

SEMESTER II										
S. No	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**J**	**C**	**Pre-requisite**
1	U18MAI2201	Advanced Calculus and Laplace Transforms	Embedded- Theory and Practical	BS	3	0	2	0	4	U18MAI1201
2	U18ENI2201	Fundamentals of Communication II	Embedded- Theory and Practical	HS	2	0	2	0	3	--
3	U18CHI2201	Engineering Chemistry	Embedded- Theory and Practical	BS	3	0	2	0	4	--
4	U18EII2201	Foundation in Electrical and Electronics Engineering	Embedded- Theory and Practical	PC	3	0	2	0	4	U18PHI1201
5	U18CSI2201	Python Programming	Embedded- Theory and Practical	ES	2	0	2	0	3	--
6	U18INI2600	Engineering Clinics II	Embedded- Theory and Practical	ES	0	0	4	2	3	--
7	U18TLR2001	Tamils and Technology	Theory	HS	1	0	0	0	1	
Total Credits									**22**	
Total Contact Hours/week									**29**	

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SEMESTER III

S. No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18EII3201	Analog Electronics	Embedded– Theory and Practical	PC	3	0	2	0	4	-
2	U18EII3202	Sensors and Measurements	Embedded– Theory and Practical	PC	3	0	2	0	4	-
3	U18BTT3006	Biology for Engineers	Theory	BS	3	0	0	0	3	-
4	U18MAT3104	Numerical Methods and Probability	Theory & Tutorial	BS	3	1	0	0	4	-
5	U18MET3007	Mechanics and Thermodynamics	Theory	ES	3	0	0	0	3	-
6	U18INI3600	Engineering Clinics III	Embedded– Practical and Project	ES	0	0	4	2	3	-
									Total Credits	**21**
									Total Contact Hours/week	**26**

SEMESTER IV

S. No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18EII4201	Electronic Signal Conditioning	Embedded- Theory and Practical	PC	3	0	2	0	4	U18EII3201
2	U18EII4202	Digital Fundamentals and Microprocessor	Embedded - Theory and Practical	PC	3	0	2	0	4	--
3	U18EII4203	Modelling and Analysis of Dynamic Systems	Embedded- Theory and Practical	PC	3	0	2	0	4	--
4	U18EIT4004	MEMS and Sensor Design	Theory	PC	3	0	0	0	3	U18EII3202
5	U18EIT4005	Ancillary Support System	Theory	PC	3	0	0	0	3	--
6	U18INI4600	Engineering Clinics IV	Embedded– Practical and Project	ES	0	0	4	2	3	--
7	U18VET4101	Universal Human Values II	Theory	HS	3	0	0	0	3	
									Total Credits	**24**
									Total Contact Hours/week	**29**

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SEMESTER V

S. No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18EII5201	Process Dynamics and Control	Embedded- Theory and Practical	PC	3	0	2	0	4	U18EII4203
2	U18EII5202	Embedded Microcontrollers	Embedded- Theory and Practical	PC	3	0	2	0	4	U18EII4202
3	U18EII5203	Field Instrumentation	Embedded Theory and Practical	PC	3	0	2	0	4	U18EII3202
4	U18EIT5004	Industrial Communication and networking	Theory	PC	3	0	0	0	3	--
5	U18EIE00- -	Professional Elective I	Theory	PE	3	0	0	0	3	--
6	U18- - - - - - -	Open Elective I	Theory	OE	3	0	0	0	3	--
7	U18INI5005	Instrumentation and Control for Process Industries	Theory	ES	3	0	0	0	3	--
								Total Credits	**24**	
								Total Contact Hours/week	**30**	

SEMESTER VI

S. No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18EII6201	Industrial Automation	Embedded -Theory and Practical	PC	3	0	2	0	4	U18EII5201 U18EII5203
2	U18EII6202	Digital Signal Processing & Deep learning	Embedded - Theory and Practical	PC	3	0	2	0	4	U18EII4203
3	U18EIE00- -	Professional Elective II	Theory	PE	3	0	0	0	3	--
4	U18- - - - - - -	Open Elective II	Theory	OE	3	0	0	0	3	--
5	U18EIT6003	Comprehensive Studies	Theory	PC	2	0	0	0	2	U18EII3201, U18EII3202, U18EII4202 U18EII5201, U18EII5203
6	U18EIE00- -	Professional Elective III	Theory	PE	3	0	0	0	3	--
								Total Credits	**19**	
								Total Contact Hours/week	**21**	

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SEMESTER VII

S. No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Prerequisite
1	U18EIT7001	Analytical Instrumentation	Theory	PC	3	0	0	0	3	U18EII3202
2	U18EII7202	Advanced Control system	Embedded - Theory and Practical	PC	3	0	2	0	4	U18EII5201
3	U18EIE00- -	Professional Elective IV	Theory	PE	3	0	0	0	3	- -
4	U18MBT7000	Engineering Economics and Financial Management	Theory	HS	3	0	0	0	3	--
5	U18EIP7703	Design project	Project Only Course	PW	0	0	0	6	3	--
								Total Credits	**16**	
								Total Contact Hours/week	**20**	

SEMESTER VIII

S. No	Course code	Course Title	Course Mode	CT	L	T	P	J	C	Pre-requisite
1	U18EIP8701	Capstone Project	Project Only Course	PW	0	0	0	24	12	U18EIP7703
								Total Credits	**12**	
								Total Contact Hours/week	**24**	

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List of Professional Electives

Electronic Automation

S. No	Course code	Course Title	Course Mode	L	T	P	J	C	Periods	CT
1	U18EIE0001	Flexible and Wearable Electronics	Theory	3	0	0	0	3	3	PE
2	U18EIE0002	Lab on a chip	Theory	3	0	0	0	3	3	PE
3	U18EIE0003	VLSI Design	Theory	3	0	0	0	3	3	PE
4	U18EIE0004	Robotics and Flexible Automation	Theory	3	0	0	0	3	3	PE

Advanced Instrumentation

S. No	Course code	Course Title	Course Mode	L	T	P	J	C	Periods	CT
1	U18EIE0005	Wireless Sensor Measurement systems	Theory	3	0	0	0	3	3	PE
2	U18EIE0006	Bio sensors and Medical Instrumentation	Theory	3	0	0	0	3	3	PE
3	U18EIE0007	Sensor and Data Fusion	Theory	3	0	0	0	3	3	PE
4	U18EIE0008	Machine Vision	Theory	3	0	0	0	3	3	PE

Process Automation

S. No	Course code	Course Title	Course Mode	L	T	P	J	C	Periods	CT
1	U18EIE0009	Fault Detection and Diagnosis	Theory	3	0	0	0	3	3	PE
2	U18EIE0010	Advanced Intelligent Controllers	Theory	3	0	0	0	3	3	PE
3	U18EIE0011	Industry 4.0	Theory	3	0	0	0	3	3	PE
4	U18EIE0012	System Identification, Modelling and Simulation	Theory	3	0	0	0	3	3	PE

GENERAL

S. No	Course code	Course Title	Course Mode	L	T	P	J	C	Periods	CT
1	U18EIE0013	Artificial Intelligence and Machine learning	Theory	3	0	0	0	3	3	PE
2	U18EIE0014	Big Data Analytics	Theory	3	0	0	0	3	3	PE
3	U18EIE0015	Cloud Computing	Theory	3	0	0	0	3	3	PE
4	U18EIE0016	Augmented reality and Virtual Reality	Theory	3	0	0	0	3	3	PE
5	U18EIE0017	Industrial Electronic Drives	Theory	3	0	0	0	3	3	PE

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Professional Electives Introduced										
S. No	**Course code**	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**	**Periods**	**CT**
1	U18EIE0018	Building Automation	Theory	3	0	0	0	3	3	PE
2	U18EIE0019	Optical Instrumentation	Theory	3	0	0	0	3	3	PE
3	U18EIE0020	Statistical Process Control	Theory	3	0	0	0	3	3	PE
4	U18EIE0021	Hybrid and Electric Vehicles	Theory	3	0	0	0	3	3	PE
5	U18EIE0022	Smart Instrumentation and IoT for Industrial Automation	Theory	3	0	0	0	3	3	PE
6	U18EIE0023	Machine Learning for Industrial Automation	Theory	3	0	0	0	3	3	PE
7	U18EIE0024	Industrial Safety and Hazardous Systems	Theory	3	0	0	0	3	3	PE

Mandatory Non-credit courses					
S.No	**Couse Code**	**Course Title**	**Course Mode**	**CT**	**Sem**
1		Universal Human Values -I	Lab	HS	I
2	U18INT6000	Constitution of India	Theory	MC	VI

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SEMESTER I

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U18ENI1201 – FUNDAMENTALS OF COMMUNICATION-I
(Common to all Branches of I Semester B.E/B/Tech Programmes)

L	T	P	J	C
2	0	2	0	3

Course Objectives:

1. To communicate effectively by using appropriate grammar and technical parlance in a range of academic scenarios.
2. To interpret and critically evaluate discourses related to functional English.
3. To disseminate professional information through appropriate means of communication.

Course Outcomes:

After the course the student will be able to:

CO1: Communicate in English with correct grammar

CO2: Communicate effectively (Oral and Written)

CO3: Use communication skills in the real world

Assessment Methods:

Direct
1. Continuous Assessment of Skills
2. Assignment
3. Written Test
4. End Semester Examination

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**		
CO2		**M**		**W**		**W**			**M**	**S**		**S**		
CO3		**M**		**M**		**W**			**M**	**S**		**S**		

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	Topic	Hours
MODULE I - 12 Hrs		
1.1	Parts of Speech	2
1.2	Subject Verb Agreement	2
1.3	Speak up (Self Introduction, JAM)	4
1.4	Writing sentences using 'Be-forms'	3
1.5	Test	1
MODULE II - 12Hrs		
2.1	Articles, Gerunds, Infinitives	2
2.2	Speak up (Greetings & Polite English)	4
2.3	Dialogue Writing	3
2.4	Skimming & Scanning	2
2.5	Listening Skills - I	1
MODULE III - 12 Hrs		
3.1	Tenses & Voice	2
3.2	Sentences & its kinds	2
3.3	Speak up (Narration & Description)	4
3.4	Summarizing & Note-making	3
3.5	Listening Skills - II	1
MODULE IV - 12 Hrs		
4.1	Framing Questions – 4 types	2
4.2	Speak up (Role play)	4
4.3	Letter writing – Formal and Informal & Email Writing	3
4.4	Reading Comprehension & Cloze test	2
4.5	Listening Skills - III	1
MODULE V - 12 Hrs		
5.1	Degrees of Comparison	2
5.2	Clauses	2
5.3	Speak up (Power Point Presentation)	4
5.4	Writing (Picture perception)	3
5.5	Test	1
Total		**60**

Reference:

1. A Modern Approach to Non Verbal Reasoning (English, Paperback, Dr. R S Aggarwal)
2. The Power of Words(Bloomsbury, UK, 2012, Hyacinth Pink)
3. Word Power Made Easy: The Complete Handbook for Building a Superior Vocabulary (By Norman Lewis)
4. Effective Technical Communication Tata Mc Graw Hills Publications (Ashraf Rizvi)
5. English and Soft skills Orient Black Swan Publishers (S. P. Dhanavel)
6. Know Your Grammar: Trans.in Tamil & Malayalam –A Bilingual Approach (Bloomsbury, UK, 2012, Hyacinth Pink)

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U18MAI1201 LINEAR ALGEBRA AND CALCULUS

(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: Identify eigenvalues and eigenvectors, apply Cayley Hamilton theorem to Matrix Manipulation and apply orthogonal diagonalisation 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)												PSOS	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S			M				M	M		M	M	
CO2	S	S			M				M	M		M	M	
CO3	S	S			M				M	M		M	M	
CO4	S	S			M				M	M		M	M	
CO5	S	S			M				M	M		M	M	
CO6	S	S			M				M	M		M	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)

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5. Model Examination (lab component)

6. End Semester Examination (Theory and lab components)

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.

REFERENCES
1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.

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1. Kreyzig E., "Advanced Engineering Mathematics", Tenth Edition, John Wiley and sons, 2011.
2. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007
3. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2008
4. Venkataraman M.K., "Engineering Mathematics", The National Pub. Co., Chennai,2003
5. Weir, MD, Hass J, Giordano FR: Thomas' Calculus, Pearson education 12th Edition, 2015
6. G.B.Thomas and R.L.Finney, Calculus and Analytical Geometry, 11th Edition, Pearson Education, (2006)
7. James Stewart, Calculus: Early Transcendentals, Cengage Learning, 7th Edition, New Delhi, 2015.

WEBSITES

1. https://www.khanacademy.org/tag/maxima-and-minima-math
2. https://www.khanacademy.org/math/differential-calculus
3. https://www.khanacademy.org/math/integral-calculus

LAB COMPONENT **30 Hours**

List of MATLAB Programmes:

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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U18 PHI1201 Engineering Physics
(Common to All B.E., B .Tech.)

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 principles of motion and rotation of a rigid body in the plane.

CO2: Enhance the fundamental knowledge in properties of matter and its applications relevant to various streams of Engineering and Technology.

CO3: Recognize the nature and role of the thermodynamic parameters.

CO4: Compute electrostatic field and electric potential due to point and distributed charges.

CO5: Use electrostatic & magneto static boundary conditions to relate fields in adjacent media.

CO6: Introduce and provide a broad view of the smart materials and Nano science to undergraduates.

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	M										M
CO2	S	M			S							M
CO3	S	M			S							M
CO4	S	M			S							M
CO5	S	M			S							M
CO6	S	M					M					M

Course Assessment methods

Direct
1. Continuous Assessment Test I, II (Theory component)
2. Cooperative learning report, Assignment; Group Presentation, Project report, Poster preparation,
3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (lab component)
4. Model examination (lab component)
End Semester Examination (Theory and lab component)

Theory Component

KINEMATICS & RIGID BODY MOTION **9 Hours**

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.

PROPERTIES OF MATTER AND MATERIALS TESTING **9 Hours**

Properties of matter: Hooke's Law Stress - Strain Diagram - Elastic moduli - Relation between elastic constants - Poisson's Ratio - Expression for bending moment and depression - Cantilever - Expression for Young's modulus by Non uniform bending and its experimental determination.

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Materials testing: Mechanism of plastic deformation, slip and twinning – types of fracture – Vickers Hardness test - fatigue and creep test.

HEAT **9 Hours**

Specific heat capacity, thermal capacity. Temperature rise. Coefficient of linear thermal expansion. Methods of measurement of thermal expansion. Thermal stresses in composite structures due to non-homogeneous thermal expansion. Applications -The bimetallic strip. Expansion gaps and rollers in engineering structures. Thermal conductivity: differential equation of heat flow. Lee's disc apparatus for determination of thermal conductivity. Thermal Insulation. Convection and radiation. Applications to refrigeration and power electronic devices.

ELECTROSTATICS & MAGNETOSTATICS **10 Hours**

ELECTROSTATICS : Maxwell's equation for electrostatics – E due to straight conductors, circular loop, infinite sheet of current - electric field intensity (D) - Electric potential - dielectrics - dielectric polarization - internal field – Clasious - Mosotti equation - dielectric strength - applications.

MAGNETOSTATICS: Maxwell's equation for magnetostatics - B in straight conductors, circular loop, infinite sheet of current - Lorentz force, magnetic field intensity (H) – Biot–Savart's Law – Ampere's Circuit Law –Magnetic flux density (B) – magnetic materials – Magnetization – Applications.

NEW ENGINEERING MATERIALS AND NANO TECHNOLOGY **8 Hours**

New Engineering Materials: Metallic glasses – preparation, properties and applications – Shape memory alloys (SMA) – characteristics, properties of NiTi alloy applications - advantages and disadvantages of SMA.

Nano Materials: synthesis - Ball milling - Sol-gel - Electro deposition — properties of nano particles and applications. – Carbon Nano Tubes – fabrication by Chemical Vapour Deposition - structure, properties & applications.

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

REFERENCES

1. Elements of Properties of Matter, Mathur D.S., Shyamlal Charitable Trust, New Delhi, 1993.
2. Properties of matter, brijlal and Subharamaniam, S.Chand and Co, New Delhi, 2004.
3. Fundamentals of General Properties of Matter by Gulati H.R., R. Chand & Co., New Delhi, 1982.
4. Engineering Mechanics (2nd ed.), Harbola M. K., Cengage publications, New Delhi, 2009.
5. Introduction to Mechanics, Verma M. K. (CRC Press), University Press, 2000.
6. Thermodynamics: An Engineering Approach (SI Units), yunus a. cengel & michael a. boles 7th edition, mcgraw-hill companies 2014.
7. Engineering Electromagnetics, W. H. Hayt and John A. Buck, 6th Edition, Tata McGraw Hill, New Delhi, 2014.
8. Electromagnetic Field Theory, 5th Edition, Gangadhar K.A. and Ramanathan P.M., Khanna Publishers, New Delhi, 2013.
9. Problems and Solutions in Electromagnetics, 1st Edition, J.A. Buck and W. H. Hayt, Tata McGraw Hill, New Delhi, 2010.
10. Theory and Problems of Electromagnetic Schaum's Outline Series, 5th Edition, Joseph A. Edminister, Tata McGraw Hill Inc., New Delhi, 2010.
11. Engineering Physics, Rajendran V., Tata McGraw-Hill Education Pvt. Ltd., 2010
12. Nano – the Essentials, Pradeep T., McGraw-Hill Education, Pvt. Ltd., 2007.

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Lab component:

LIST OF EXPERIMENTS

1. Determination of thermal conductivity of a bad conductor - Lee's disc
2. Determination of Acceleration due to Gravity – Compound Pendulum
3. Determination of wavelength of light, Numerical aperture and acceptance of optical fibre
4. Determination of band gap of a semiconductor
5. Determination of compressibility of a given liquid - Ultrasonic Interferometer
6. Determination of thickness of thin sheet – Air wedge
7. Determination of frequency of an electrically maintained turning fork – Melde's string
8. Determination of wavelength of mercury source using diffraction grating - Spectrometer
9. Determination of solar cell efficiency using Lux Meter
10. Determination of Young's Modulus – Non-uniform bending

Experiments for Demonstration:

1. Hall effect
2. Hardness Test
3. Four probe experiment
4. Hysteresis curve

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

REFERENCES

1. Laboratory Manual of Engineering Physics, Dr. Y. Aparna & Dr. K. Venkateswara Rao, V.G.S Publishers.
2. Practical Physics, G.L. Squires, Cambridge University Press, Cambridge, 1985.
3. Great Experiments in Physics, M.H. Shamos, Holt, Rinehart and Winston Inc., 1959.
4. Experiments in Modern Physics, A.C. Melissinos, Academic Press, N.Y., 1966.

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U18MEI1201 **ENGINEERING GRAPHICS**
(Common to AE, AUE, CE, MCE, ME, EIE and EEE)

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: Construct various plane curves.(K2)
CO2: Construct projection of points and projection of lines. .(K2)
CO3: Develop projection of surfaces and solids. (K2)
CO4: Solve problems in sections of solids and development of surfaces. (K2)
CO5: Apply free hand sketching and concepts of isometric in engineering practice. (K2)
CO6: Draw engineering drawing in AutoCAD with dimensions. (K2)

Pre-requisite : Nil

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	PSO2
CO1	S	M												W
CO2	S	S									W			W
CO3	S	S									M			W
CO4	S	S												W
CO5	S	S												W
CO6	S													W

Course Assessment methods

Direct

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

Theory Component contents

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, 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

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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.
Isometric projection, Isometric scale, Isometric views of simple solids, truncated prisms, pyramids, cylinders and cones.
Free hand sketching techniques, sketching of orthographic views from given pictorial views of objects, including free-hand dimensioning.

PRACTICAL

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 the objects – copy, move, trim, extend, working with arrays, mirror, scale, hatch, fillet and chamfer.

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: 60 Hours**

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. Nataraajan K.V., Engineering Drawing and Graphics, Dhanalakshmi Publisher, Chennai, 2005.
4. Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., New Delhi, Eleventh Edition, 2005.
5. Gopalakirishna 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 of different problem-solving techniques. (K2)
CO2: Use appropriate data types and control structures for solving a given problem. (K3)
CO3: Execute different array and string operations. (K3)
CO4: Experiment with the usage of pointers and functions. (K3)
CO5: Organize data using structures and unions. (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
CO1	S	M							L			
CO2	S	M							L	L		
CO3	S	L			L	L			L	L		L
CO4	M	L	M	L	L	L			L	L		M
CO5	M	L	M	L	L	L			L	L		M

Course Assessment methods

Direct

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)

Theory Component contents

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 –

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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 arrays to 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.

LAB COMPONENT CONTENTS **30 Hours**

LIST OF EXPERIMENTS

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

REFERENCES

1. Byron S Gottfried and Jitendar Kumar Chhabra, “Programming with C”, Tata McGraw Hill Publishing Company, Third Edition, New Delhi, 2011.
2. PradipDey and ManasGhosh, “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. ReemaThareja, “Programming in C”, Second Edition, Oxford University Press, 2011.

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U18INI1600 ENGINEERING CLINICS - 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 team work
- 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 problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite:

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

COs	Programme Outcomes(POs)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S	M	W		S			S	S	
CO2											S			
CO3										S				

Course Assessment methods:

Direct
1. Project reviews 50%
2. Workbook report 10%
3. Demonstration& Viva-voce 40%

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.

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In the I semester, students will focus primarily on IOT with C programming using Audino.

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 tasks, 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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U18TLR1001- HERITAGE OF TAMILS - SEMESTER 1

Course Outcomes

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

to CO1: Enhance the fundamental knowledge of tamil language and

literatureCO2: 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

Assessment methods Direct

1.Continuous Assessment Test

I, II2.Two Assignments

3.End Semester Examination

UNIT I LANGUAGE AND LITERATURE

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

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

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

UNIT III FOLK AND MARTIAL ARTS

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

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UNIT IV THINAI CONCEPT OF TAMILS

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 ANDINDIAN 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.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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 Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
8. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

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SEMESTER II

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L	T	P	J	C
3	0	2	0	4

U18MAI2201 ADVANCED CALCULUS AND LAPLACE TRANSFORMS

(Common to All branches)

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: Solve linear differential equations using Laplace transform technique.

CO6: Determine multiple integrals, vector differentials, vector integrals and Laplace transforms using MATLAB.

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
CO1	S	S			M				M	M		M
CO2	S	S			M				M	M		M
CO3	S	S			M				M	M		M
CO4	S	S			M				M	M		M
CO5	S	S			M				M	M		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 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)

THEORY COMPONENT

MULTIPLE INTEGRALS **9 Hours**

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

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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 conditions, Cauchy-Riemann equations in Cartesian coordinates and sufficient conditions (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.

REFERENCES

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 41st Edition, 2011.
2. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.
3. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007.
4. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics", S. Chand & Co., New Delhi, (Reprint) 2008.
5. Kreyzig E., "Advanced Engineering Mathematics", Tenth Edition, John Wiley and sons, 2011.
6. Venkataraman M.K., "Engineering Mathematics", The National Pub. Co., Chennai, 2003.
7. Weir, MD, Hass J, Giordano FR: Thomas' Calculus Pearson education 12th ED, 2015.

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LAB COMPONENT **30 Hours**

List of MATLAB Programmes:

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 applying convolution.
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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U18ENI2201 – FUNDAMENTALS OF COMMUNICATION – II

L	T	P	J	C
2	0	2	0	3

(Common to all branches of II Semester B.E/B/Tech Programmes)

Course Objectives:

1. To effectively use the basic language skills to imbibe technical language skills.
2. To hone written and spoken competencies leading to effective communication.
3. To comprehend, use and explain technical data and information.

Course Outcomes:

After the course the student will be able to:

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

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

CO3: Compare, collate and present technical information according to the audience and purpose.

Assessment Methods

Direct
1. Continuous Assessment of Skills
2. Assignment
3. Written Test
4. End Semester Examination

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		**W**		**S**					**S**	**S**		**S**		
CO2				**S**					**S**	**S**		**W**		
CO3				**M**					**S**	**S**		**S**		

No	TOPIC	
	MODULE I	**12 Hrs**
1.1	Introduction to Technical Writing Technical Definitions	2
1.2	Writing Instructions / Instruction Manual	2
1.3	Writing Recommendations	2

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1.4	Speaking Activity I	6
	MODULE II	**12 Hrs**
2.1	Process Writing	2
2.2	Review Writing I - Product	2
2.3	Review Writing II – Article	2
2.4	Speaking Activity II	6
	MODULE III	**12 Hrs**
3.1	Interpreting and Transcoding Graphics	2
3.2	Types of Report / Writing a Report	2
3.3	Reading & Responding to texts	2
3.4	Speaking Activity III	6
	MODULE IV	**12 Hrs**
4.1	Drafting a project proposal	2
4.2	Listening to technical talks	2
4.3	Preparing a survey Questionnaire	2
4.4	Speaking Activity IV	6
	MODULE V	**12 Hrs**
5.1	Writing Memos, Circulars, Notices	2
5.2	Writing Agenda and Minutes	2
5.3	Inferential Reading	2
5.4	Speaking Activity V	6
	Total	**60**

Reference Books:

1. Technical English Workbook, VRB Publishers Pvt. Ltd (Prof. Jewelcy Jawahar, Dr.P.Ratna)
2. Effective Technical Communication, Tata McGraw Hills Publications (Ashraf Rizvi)
3. Technical Communication – English Skills for Engineers, Oxford Higher Education (Meenakshi Raman, Sangeeta Sharma)

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U18CHI2201

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-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
CO1	S	M										
CO2	S	M		M								
CO3	S	M		S								
CO4	S	M		S								
CO5	M	S		S								

Course Assessment methods

Direct

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

Theory Component

CHEMICAL BONDING **7 Hours**

Bonding: Introduction – Ionic bonding - Van der Waal's forces (dipole - dipole, dipole - induced dipole, induced dipole - induced dipole interactions) - hydrophobic interaction.

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Bonding in organic molecules: covalent and co-ordinate bonds (overview only) - hybridization (sp, sp2, sp3) - hydrogen bonding and its consequences.

THERMODYNAMICS **7 Hours**

Introduction - Thermodynamic process – Internal energy – Enthalpy – limitations of First law of thermodynamics – Second law of thermodynamics - Entropy - Third law of thermodynamics – Free Energy and Work Function – Clausius-Clapeyron equation – Maxwell's relations – Kirchhoff's equation.

ELECTROCHEMISTRY AND CORROSION **7 Hours**

Electrodes - Electrode Potential – Nernst equation and problems - Galvanic cell - Electrochemical Series.

Corrosion: Classification and mechanism of chemical and electrochemical corrosion - Factors influencing corrosion

Corrosion control: Inhibitors – Cathodic protection (Sacrificial anodic protection, Impressed current cathodic protection) – Protective coating: Electroplating (Au) and Electroless plating (Ni).

WATER TECHNOLOGY **6 Hours**

Introduction - soft/hard water - Disadvantages of hard water in industries– scale, sludge, priming and foaming, caustic embrittlement.

Treatment of hard water: External treatment (Ion exchange method) - Internal treatment (colloidal, carbonate, phosphate and calgon conditioning) - Desalination (Reverse osmosis, Electrodialysis)

ENGINEERING MATERIALS **9 Hours**

Polymer: Introduction – Preparation, Properties and Applications of PMMA, PET, PVC.

Composites: Constituents of Composites – Polymer Composites - Metal Matrix Composites - Ceramic Matrix Composites – Applications

Lubricants: Classification - Functions - Properties (viscosity index, flash and fire point, oiliness, carbon residue, aniline point, cloud point and pour point) - Semi solid lubricant (greases with calcium based, sodium based, lithium based) - Solid lubricants (graphite, molybdenum disulphide)

SURFACE CHEMISTRY AND CATALYSIS **9 Hours**

Adsorption: Types of adsorption – Adsorption isotherms: Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Applications of adsorption on pollution abatement.

Catalysis: Catalyst – catalytic poisoning and catalytic promoters - autocatalysis –- acid base catalysis – enzyme catalysis – Michaelis-Menten equation – applications.

Chemical kinetics: Introduction – first order, pseudo first order, second order, zero order equations – parallel reactions – opposing reactions.

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

REFERENCES

1. Jain P.C. and Jain. M., Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, Reprint 2017.

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

LABORATORY COMPONENT

LIST OF EXPERIMENTS

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: 0**	**Practical: 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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U18EII2201	Foundation in Electrical and Electronics Engineering	L	T	P	J	C
		3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Analyse the given DC circuits and AC resonant circuits (K4)

CO2: Solve the given networks by applying circuit theorems. (K3)

CO3: Explain the characteristics and applications of various electronic devices. (K2)

CO4: Illustrate the concepts of electrical machines and transformers. (K3)

CO5: Simulate and analyze the given electrical and electronics circuit. (K4)

CO6: Demonstrate the characteristics of DC shunt motor, single phase induction motor and single-phase transformer. (K4)

Pre-requisite: U18PHI1201 – Engineering Physics

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

Course Assessment Methods:

Direct
• Model Lab Exam • End Semester Practical Exam • End Semester Exam • Assignments

Course Content:

ELECTRIC CIRCUITS **12 Hours**

Basic Definitions: Charge, Current, Voltage and Power, Element types, Circuit elements characteristics: Resistors, Inductors, capacitors - Voltage and Current Sources - Ohm's Law, Kirchhoff's Current Law, Kirchhoff's Voltage Law, Circuit Elements in Series and Parallel, Voltage and Current Division, Source Transformation, Delta-Star and Star- Delta transformation, Mesh and Nodal analyses. AC analysis: Phasors and Resonance.

NETWORK THEOREMS **8 Hours**

Superposition - Thevenin – Norton - Maximum Power Transfer - Reciprocity Theorems and Applications.

CHARACTERISTICS OF DIODES &TRANSISTORS **9 Hours**

p-n junction diode– Temperature effect of p-n junction –Transition and diffusion capacitance – Zener diode - Junction transistor– Transistor construction– CE, CB and CC configurations, JFET – UJT – PUT – MOSFET - IGBT.

CHARACTERISTICS AND APPLICATIONS OF OTHERD E V I C E S **9 Hours**

SCR, TRIAC, LED, LCD, photo conductive cell, photo diode, solar cell, phototransistor,

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optocouplers, laser diode, tunnel diode and Varactor diode.

ELECTRICAL MACHINES **7 Hours**

Construction, Working Principle and applications of DC generators, DC Motors, single phase Transformers, Autotransformer, three phase and single phase induction motors.

REFERENCES

1. Jacob Millman, ChristosC. Halkias,Electronic DevicesandCircuits, Tata McGrawHillPublishingLtd.,NewDelhi,2010.
2. Salivahanan S. and Suresh Kumar N., Electronic Devices and circuits, Tata McGraw Hill Publishing Ltd., New Delhi, 2012.
3. Tony R. Kuphaldt, "Lessons In Electric Circuits, Volume II – AC", 6thEdition, last update July 25, 2007.
4. J. B. Gupta, "Theory & Performance of Electrical Machines", S. K. Kataria& Sons, 2013.
5. Charles K. Alexander and Mathew N.O. Sadiku, Fundamentals of Electric Circuits, 5th edition, McGraw-Hill, 2013.
6. William H. Hayt, Jr Jack E. Kemmerly and Steven M. Durbin, Engineering Circuit Analysis,8th edition, MC GrawHill, 2013.

List of Experiments:

1	Identification of Component and its Specifications - Resistor, Inductor, Capacitor. Introduction to the use of CRO, Function generator, Multimeter.
2	Introduction to Simulation Tools. Simulation and verification of Ohm's Law & Kirchhoff's Laws, Star to Delta and Delta to Star conversions.
3	Practical verification of Ohm's Law & Kirchhoff's Laws, Star to Delta and Delta to Star conversions
4	Application of circuits - Staircase wiring using switches, fuse, indicator, lamp, energy meter.
5	Simulation and practical verification of Superposition - Thevenin – Norton Theorems.
6	Simulation and practical verification of Maximum Power Transfer - Reciprocity Theorems.
7	Applications of Network Theorems – Eg. Loud Speaker, Thermistor linearization.
8	Simulation and practical verification of Characteristics of Diodes using CRO and Meters.
9	Simulation and practical verification of Characteristics of CE, CB configurations in BJT. Amplifier Demo.
10	Simulation and practical verification of Characteristics of JFET and MOSFET.
11	Simulation and practical verification of Characteristics of SCR and TRIAC.
12	Simulation and practical verification of Characteristics of LED, Photo Diode and Photo Transistor. Opto-isolator demo.
13	Performance evaluation of DC Shunt Motor and practical selection criteria.
14	Performance evaluation of Single phase Induction Motor and practical selection criteria.
15	Performance evaluation of single phase transformer.

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

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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)
CO2:	Experiment with the various control statements in Python.(K3,S2)
CO3:	Develop Python programs using functions and strings.(K3,S2)
CO4:	Analyze a problem and use appropriate data structures to solve it.(K4,S3)
CO5:	Develop python programs to implement various file operations and exception handling.(K3,S2)

Pre-requisites :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	PO 11	PO12	PS O1	PSO2
CO1		S			M					M		M		
CO2			M							M		M		
CO3			M							M		M		M
CO4	S	S	M		M					M		M	M	M
CO5			M							M		M		

COURSE ASSESSMENT METHODS

DIRECT

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)

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

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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: 0	Total: 30 Hours

REFERENCES

1. Ashok NamdevKamthane,Amit Ashok Kamthane, “Programming and Problem Solving with Python” , Mc-Graw Hill Education,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 Dierbach, “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 30 Hours

LIST OF EXPERIMENTS

1. Implement simple python programs using interactive and script mode.
2. Develop python programs using id() and type() functions
3. Implementrange() 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.

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7. Implementuser 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: 30 Hours

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 CLINICS - 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 team work

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 problems and find a solution
CO2: Understand the project management techniques
CO3: Demonstrate their technical report writing and presentation skills

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	S	S	S	S	M	W		S			S	S	
CO2											S			
CO3										S				

Course Assessment methods:

Direct
1. Project reviews 50%
2. Workbook report 10%
3. Demonstration& Viva-voce 40%

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 II semester, students will focus primarily on Raspberry pi based controllers with Python programming.

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GUIDELINES:

7. Practical based learning carrying credits.
8. Multi-disciplinary/ Multi-focus group of 5-6 students.
9. Groups can select to work on a specific tasks, or projects related to real world problems.
10. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
11. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.
12. 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 - SEMESTER 2

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 expertise of tamil in the design and construction technology

CO3: Acquire an essential knowledge of tamil in manufacturing technology

CO4: Gain the knowledge of contribution by tamils in agriculture and irrigation technology

CO5: Gain the knowledge of scientific tamil & tamil computing

Assessment methods Direct

1.Continuous Assessment Test I, II

2.Two Assignments

3.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 evidences - Gem stone types describedin 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.

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UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING

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

TOTAL : 15 PERIODS TEXT-CUM-REFERENCE BOOKS

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 ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand 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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U18EII3201 **ANALOG ELECTRONICS**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Apply simple models of bipolar junction transistors, field effect transistors and operational amplifiers, to predict the behaviour of amplifier circuits (K3)

CO2: Explain the fundamental concepts and operating characteristics of operational amplifiers. (K2)

CO3: Utilize operational amplifiers for building linear and non-linear applications (K3)

CO4: Design a precision amplifier using Op-amp with required specifications and a low noise amplifier using bipolar and field effect transistors. (K5)

CO5: Design, construct and take measurements of various analog circuits to compare experimental results in the laboratory with theoretical analysis. (K6)

CO6: Design and implement high precision circuit for sensor interface and bipolar transistor and JFET with low noise (K6)

Pre-requisite: --

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	L	M							M	S	
CO2	M	L											M	
CO3	S	M	L	L	M					M		M	S	
CO4	S	S	M	M								M	M	
CO5	S	S	M	M	S				S	M	M		S	
CO6	S	S	M	M	S				S				S	

Course Assessment Methods:

Direct
• Model Lab Exam • End Semester Practical Exam • End Semester Exam • Assignments

Course Content:

ANALYSIS OF BIPOLAR AND UNIPOLAR TRANSISTOR BASED AMPLIFIERS **12 Hours**

Introduction-Load line- Biasing a BJT-Transistor modelling-Small signal practical CE amplifier under h parameter model-Amplifier frequency response-half power gain-CE amplifier at low frequency-CE amplifier at high frequency-Total frequency response-CE amplifier in cascade-overall gain of amplifier in cascade- frequency response.
Introduction- Biasing a JFET-Field effect transistor as amplifier. Feedback configurations. Power amplifier operating classes – Class A, B, AB, c, D, S-power efficiency and analysis.

OPERATIONAL AMPLIFIER **7 Hours**

Small signal analysis of Differential amplifier- DC and AC characteristics of Op-amp, open

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loop and closed loop operation of OP-amp. -OPamp frequency response.

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APPLICATIONS OF OPERATIONAL AMPLIFIER **9 Hours**

Inverting amplifier- non inverting amplifier- Voltage follower -differential amplifier- Instrumentation amplifier, isolation amplifier, chopper amplifier

Differentiator, integrator, clipper, clamper, Sample and hold circuit, V-I converter, I-V converter. Multivibrator, comparator- Filter-Low pass response – high pass response- band pass response-fourth order response- Filter design using standard tables.

OSCILLATORS AND TIMERS **7 Hours**

Waveform generator-sine, square and Ramp wave - IC 555 timer – functional block- operation under Astable- Monostable mode. Applications of IC555 timer.

PRECISION OPAMP DESIGN AND LOW NOISE TECHNIQUE **10 Hours**

Precision opamp design techniques- high speed Opamp technique-choosing precision opamp-design of precision amplifier

Noise -low noise design with bipolar transistor and JFET-Noise in differential and feedback amplifiers-Noise in operational amplifier.

List of Experiments:

1 Introduction to MyDAQ and Reading data sheets of various Transistors.
2. Study of trouble shooting strategies.(open/short circuit, series/parallel circuits, Transistor/Op-amp circuits)
3. Design, simulation and implementation of small signal amplifier using BJT and FET.
4. Design, simulation and implementation of power amplifier and calculating the power efficiency.
5 Project- Audio Amplifier
6 Practical Verifications of characteristics of Op-amp.
7 Interfacing a sensor to the Instrumentation/chopper amplifier and find the gain.
8 Design and implementation of wave shaping circuits.
9 Design and Build a temperature controlled system using Op-amp as a ON/ OFF controller
10 Design and build a function generator capable of generating square, sine and ramp wave.
11 Design and build the humidity detector using IC555 timer
12 Design and implementation of input protection and conditioning circuit in precision Op-Amp
13 Design and implementation of high precision circuit for sensor interface.
14 Design of bipolar transistor and JFET with low noise
15 Project – Design a signal conditioning unit for a sensor.

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

Reference books:

1. Herando Lautaro Fernandez-canque, ”Analog Electronics Applications-Fundamentals of Design and Analysis”, CRC press,2017.
2. Horowitz and Hill, “The art of Electronics”3rd Edition, Cambridge university press.
3. Walt Jung, Editor Emeritus,”Op-Amp Applications Handbook”, Elsevier 2015
4. Robert L.Boylestad, Louis Nashelsky,”Electronic Devices and Circuit Theory”,11th Edition,Pearson,2013
5. David A. Bell, “Electronic Instrumentation and Measurements”, Oxford University Press Third Edition,2013.

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U18EII3202 SENSORS AND MEASUREMENTS

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to : CO1: Describe the characteristics and construction details of different sensors. (K2)

CO2: Analyze suitable signal conditioning circuits for resistive, reactance and self generating sensors. (K4)

CO3: Explain the fundamental concepts afnd working principle of analog and digital meters. (K2)

CO4: Analyze the specification details for the given sensor/Instrument

CO5: Demonstrate the Calibration of temperature sensors and electrical meters like voltmeter and ammeter. (K3)

CO6: Evaluate a measurement system using sensor and signal conditioning circuits for an application. (K5)

Pre-requisite: --

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

Course Assessment Methods:

Direct
• Continuous assessment test • Model Lab Exam • End Semester Exam • Assignments

Course Content:

INTRODUCTION TO SENSOR BASED MEASUREMENT SYSTEM: 4 Hours

General concepts and terminology, Sensor classifications, Primary Sensors, Materials for Sensors, Microsensor Technology, and Specification details of sensors/ Instruments –static and dynamic. Transduction principles

RESISTIVE SENSORS AND SIGNAL CONDITIONING: 10 Hours

Potentiometers, Strain gauges, FSR, Resistive bendy sensors, RTDs, Thermistors, Magnetoresistors, LDRs, Resistive Hygrometers, Resistive Gas Sensors, Liquid Conductivity Sensors. Measurement of Resistance: Voltage Dividers, Wheatstone Bridge -Balance Measurements, Deflection Measurements.

REACTANCE VARIATION SENSORS AND SIGNAL CONDITIONING: 9 Hours

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Capacitive Sensors - variable and differential. Inductive Sensors-Variable reluctance and eddy

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current sensors –LVDTs - Synchros, resolvers, and Inductosyn - Magnetoelastic and magnetostrictive sensor - Wiegand and pulse-wire sensors - Saturation-core (flux-gate) sensors – SQUIDs. AC Bridges - Signal Conditioner for LVDT - Specific Signal Conditioners for Capacitive Sensors - Resolver-to-Digital and Digital-to-Resolver Converters.

SELF-GENERATING SENSORS AND SIGNAL CONDITIONING: 7 Hours

Thermoelectric Sensors: Thermocouples, Piezoelectric Sensors, Pyroelectric Sensors, Photovoltaic Sensors, Electrochemical Sensors.

DIGITAL, INTELLIGENT AND OTHER SENSORS: 6 Hours

Position Encoders, Resonant Sensors, Variable Oscillators, Conversion to Frequency, Period, or Time Duration. Smart sensors. Sensors Based on Semiconductor Junctions, Sensors Based on MOSFET Transistors, Charge-Coupled and CMOS Image Sensors, Fiber-Optic Sensors, Ultrasonic-Based Sensors, Biosensors.

ANALOG AND DIGITAL METERS: 9 Hours

Moving iron- permanent magnet moving coil instruments, Measurement of DC, AC voltage and current, Hall effect clamp meter, power meter, Q-meter, Digital voltmeter, Digital multimeter, Timer/counter, time, phase and frequency measurements, oscilloscope and data loggers.

LIST OF EXPERIMENTS:

1 Introduction to simulation tools : Matlab and LabView
2. Reading data sheets of various sensors.
3. Practical verification of Strain gauge sensor specifications with the signal conditioning circuits.
4. Practical verification of RTD and Thermistor sensor specifications with the signal conditioning circuits.
5 Practical verification of Capacitive Sensors specifications with the signal conditioning circuits.
6 Practical verification of Hall efffect Sensors specifications with the signal conditioning circuits.
7 Practical verification of LVDT Sensors specifications with the signal conditioning circuits.
8 Practical verification of Magnetostrictive Sensors specifications with the signal conditioning circuits.
9 Practical verification of Thermocouple Sensors specifications with the signal conditioning circuits.
10 Practical verification of Piezoelectric Sensors specifications with the signal conditioning circuits.
11 Practical verification of Photovoltaic Sensors specifications with the signal conditioning circuits.
12 Study of Fiber-Optic Sensors, Position Encoders and Ultrasonic-Based Sensors
13 Calibrate voltmeter and an ammeter using Electrical calibration Test Bench
14 Calibrate RTD and Thermistor using Temperature Calibration Test Bench
15 Project – Design and testing of a measurement system.

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

REFERENCE BOOKS:

1. Ramon Pallas-Areny, John G. Webster ,"Sensors and Signal Conditioning" , John Wiley and Sons, 2nd Edition, 2001.
2. David A. Bell, "Electronic Instrumentation and Measurements", Oxford University Press, Third Edition,2013.
3. Kalantar-zadeh, Kourosh "SENSORS An introductory course", Springer, 2013
4. Herman K.P. Neubert, "Instrument Transducers-An introduction to their performance and design", Oxford University Press, second Edition, 2011
5. E.A. Doebelin, 'Measurement Systems – Applications and Design', Tata Mc Graw Hill, sixth edition,2012.

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U18BTT3006 **Biology for Engineers**

L	T	P	PJ	C
3	0	0	0	3

Course Objectives:

The objective of the course to give students an overall idea about the origin of life, biological system and the engineering problems associated with it.

Course Outcomes (COs):

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

CO1: Understand the basics of evolution.

CO2 Learn the composition of cells and information storage and transfer in cells.

CO3: Obtaining an overview on the various biological system and engineering problems

CO/PO/PSO 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		
CO2	S				M							S		
CO3	S	S	M		M	S						S	S	

Course Assessment methods:

	Direct
1	Continuous Assessment Tests
2	Assignments
3	End Semester Examination

Basis of Life: **4 Hours**

Origin of life –theory of evolution, Uniqueness of life on earth; Characteristics of living organisms, Tree of life classification –archaea, prokaryotes, eukaryotes, Viruses and life in extremophiles

Composition of cells: **9 Hours**

Biomolecules and their functions; Types of cells; organelles and tissues. Organs and physiological systems, Methods to study cellular function (enzymatic reactions, specific Ag-Ab reactions, separation –chromatography, centrifugation, radioisotopes).

Case Study: Analytical Methods in Biological Sample Analysis – Blood, Urine

Information storage and transfer **11 Hours**

Heredity and DNA; organization of DNA in cells; Genes and chromosomes; Central dogma of information transfer; transcription and Protein synthesis; Cell division and cell cycle. Mutation and cancer.

Case Study: Personalized Medicine

Systems to carry out Biological work: **9 Hours**

Molecular systems- Protein –workhorses of cells : Hemoglobin (O2 transport); Insulin (metabolic control); Antibodies (immunity); Collagen (structural); Na, K, ATPase (Membrane potential, transport); ATP synthase (ATP synthesis); Physiological systems: Circulatory system and heart;

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Nervous system; Muscular system.

Case Study: Wearable Electronics

Engineering biological systems: 7 Hours

Cell culture (biologics production; Hydroponics/ Aeroponics); Stem cell therapy; RNAi; Monoclonal antibodies.

Technology –Biology interface: 5 hours

Biosensors (Glucose biosensor construction); Tissue engineering (scaffolding); Lab-on-chips.

Case Study: biomaterials (metallic and ceramic implants)

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

REFERENCES

1. William, T. (2009). *Introduction to biotechnology*. Pearson Education India.
2. Campbell, N. A., Mitchell, L. G., Reece, J. B., & Taylor, M. R. (2000). *Biology: concepts & connections* (No. QH308. 2 C35 1996). Benjamin/Cummings.
3. Fumento, M. (2003). Bioevolution: how biotechnology is changing our world.
4. Kumar, H. D. (1998). Textbook on Biotechnology. *Indian Journal of Pharmacology*, *30*(4), 275.
5. Taylor, D. J., Green, N. P., Stout, G. W., &Soper, R. (1997). *Biological science* (Vol. 983). Cambridge, United Kingdom: Cambridge University Press.

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U18MAT3104 **NUMERICAL METHODS AND PROBABILITY**

(EIE)

L	T	P	J	C
3	1	0	0	4

COURSE OUTCOMES

After successful completion of this course, the students will 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
CO1	S	S										
CO2	S	S										
CO3	S	S							M			
CO4	S	S										
CO5	S	S							M			
CO6	S	S										

COURSE ASSESSMENT METHODS

Direct

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

SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS **9+3 Hours**

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

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methods – Inverse of matrix by Gauss – Jordan method – Eigenvalues of a matrix by Power method.

INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3 Hours

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+3 Hours

Single step methods: Taylor's series method – Euler and Improved Euler methods for solving a 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: 45 Hours	**Tutorials: 15 Hours**	**Total: 60 Hours**

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.
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 Kapur V.K "Fundamentals of Applied Statistics", Sultan Chand, New Delhi, 4th Edition, 2014.

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U18MET3007 **MECHANICS AND THERMODYNAMICS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):
After Successful completion of this course, the students will be able to :
CO1: Explain the concepts of thermodynamics and mechanisms of heat transfer.
CO2: Discuss the working of turbines and boilers.
CO3: Apply the fundamental concepts in determining the effect of forces on a particle.
CO4: Apply the concept of Euler and Bernoulli's equation for solving fluid flow problems.
CO5: Analyze the performance of various fluid machines.
Pre-requisite: Nil

COs	PO											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2	S											
CO3	M											
CO4		M										
CO5		M										

Course Assessment Methods:

Direct
• Internal tests • Assignments • End Semester Exam

Course Content:

BASIC OF THERMODYNAMICS AND HEAT TRANSFER **9 Hours**

Thermodynamic systems – Types, Properties, State - process - Cycle – Equilibrium – Work and heat transfer – First law of thermodynamics for non-flow process (closed system) – First law applied to Flow process (open system) - SFEE (Steady flow energy equation) – Second law of thermodynamics – Heat engines – Refrigerators and heat pumps (Descriptive only). Modes of Heat transfer- One dimensional Conduction heat transfer (Steady state) – composite walls, Convection heat transfer – Free and Forced convection- Cooling of electronic components: Thermoelectric cooling – Chip cooling (Descriptive only).

STEAM BOILERS AND TURBINES **9 Hours**

Formation of steam – properties of steam –working principle – Types of boilers-Mounting and accessories (Descriptive only). Steam power cycle (Rankine), Steam turbines: Impulse and reaction principle (Descriptive only).

SOLID MECHANICS **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

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particle - Centre of gravity, Centre of mass and Centroid – Moment of Inertia of simple areas – Transfer formula – Radius of gyration – Polar moment of inertia – Product of inertia - Mass moment of Inertia of simple solids. Kinetics – Newton's law – D'Alembert's Principle – Work Energy method – Principle of Impulse momentum – Impact of elastic bodies.

FLUID PROPERTIES AND FLOW KINEMATICS **9 Hours**

Fluid properties – Viscosity – Surface Tension – Capillarity – Fluid Pressure and Pressure Head – Types of Fluid Flow – Flow Lines – Continuity Equation. Euler's equations – Bernoulli's Equation and Applications – Venturi meter, orifice meter and pitot tube.

FLUID MACHINES **9 Hours**

Pumps - definition and classifications - Centrifugal pump - Working Principle - performance curves, Reciprocating pump- Working principle. Turbines: Definition and classifications - Pelton turbine - Francis turbine - Kaplan turbine - working principles.

Theory Hours : 45 **Total Hours : 45**

REFERENCES:

1. R. K. Bansal, Fluid Mechanics & Hydraulic Machines – Lakshmi PublicationsPvt., Ltd. 2011
2. S. Domkundwar, C. P. Kotandaraman & A. V. Domkundwar, Thermal Engineering, Dhanpat Rai & Co, 2012
3. P. K. Nag, 'Engineering Thermodynamics Tata McGraw Hill, New Delhi, 2013.
4. R. S. Khumi & J. K. Gupta, Thermal Engineering, S Chand & Co Ltd. 2009.
5. K. L. Kumar, Engineerng Fluid Mechanics, S. Chand & Company Ltd., 2008.
6. Beer F P and Johnson E R, "Vector Mechanics for Engineers, Statics and Dynamics", Tata Mc-Graw Hill Publishing Co. Ltd., New Delhi, 2006
7. P. N. Modi & S. M. Seth, "Hydraulic & Fluid Mechanics including Hydraulic Machines, Standard Book 2010.
8. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi, 2006
9. Rajput, B. K. Sankaar, "Thermal Engineering", S. Chand & Co. Ltd., 2007.

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U18INI3600 **ENGINEERING CLINICS - III**

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 team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify a practical problems and find a solution

CO2: Understand the project management techniques

CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite: Nil

COs	PO													
	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		S	
CO3										S				

Course Assessment Methods:

Direct
1. Project reviews 50%
2. Workbook report 10%
3. Demonstration& Viva-voce 40%

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 III semester, students will focus primarily on Design project combining concepts learnt in Engineering clinics I and II.

GUIDELINES:

13. Practical based learning carrying credits.
14. Multi-disciplinary/ Multi-focus group of 5-6 students.
15. Groups can select to work on a specific tasks, or projects related to real world problems.
16. Each group has a faculty coordinator/Instructor who will guide/evaluate the overall group as well as individual students.
17. The students have to display their model in the 'Engineering Clinics Expo' at the end of semester.

The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18CHT3000 ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to All branches)

L	T	P	J	C
3	0	0	0	0

Course Outcomes

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

CO 1:Analyze the impact of engineering solutions in a global and societal context.

CO 2:Discuss contemporary issues that results in environmental degradation and would attempt to provide solutions to overcome those problems.

CO 3:Highlight the importance of ecosystem and biodiversity.

CO 4:Consider issues of environment and sustainable development in his/her personal and professional undertakings.

CO 5:Paraphrase the importance of conservation of resources.

CO 6:Play an important role in transferring a healthy environment for future generations.

CO/PO Mapping

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

COs	Programme Outcomes (POs)											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		M					S		M			
CO 2						M				M		
CO 3							M					
CO 4						M	S					
CO 5							S					
CO 6			W				S					M

Course Assessment methods

Direct

1. Internal Test I
2. Internal Test II
3. Assignment

Group presentation

INTRODUCTION TO ENVIRONMENTAL STUDIES AND ATURAL 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, rain water harvesting, watershed management.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

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.

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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, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (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: 45 Hours	**al: 45 Hours**

REFERENCES

1. G. Tyler Miller and Scott Spoolman, 'Environmental Science', Fourteenth Edition, Brooks Cole, 2012.
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', Mapin Publishing Pvt. Ltd., Ahmedabad, 2002.
4. Trivedi R.K and P.K.Goel, 'Introduction to Air Pollution', Techno-Science Publications, 2003.
5. Trivedi R.K., 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media, 1996.
6. Cunningham, W.P.Cooper and T.H.Gorhani, 'Environmental Encyclopedia', Jaico Publication House, Mumbai, 2001.
7. Wager K.D., 'Environmental Management', W.B. Saunders Co., Philadelphia, USA, 1998.
8. Colin R. Townsend, Michael Begon and John L. Harper, 'Essentials of Ecology', Third Edition, Blackwell Publishing, 2008.

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SEMESTER IV

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U18EII4201 **ELECTRONIC SIGNAL CONDITIONING**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Explain the principles of linear and non-linear applications of Op-Amps and design circuits based on them. (K3)

CO2: Examine the characteristics and performance of various analog filters. (K4)

CO3: Classify different types of data converters and explain their working principles. (K4)

CO4: Illustrate the functions of voltage regulators, oscillators, relays, and phase-locked loops (PLL) in different applications. (K3)

CO5: Design and simulate analog circuits including Op-Amp applications, filters, converters, oscillators, relays, and PLL. (K5)

CO6: Design, construct, and experimentally validate various analog circuits, including Op-Amp applications, filters, converters, oscillators, relays, and PLL. (K6)

Pre-requisite: U18EII3201 - Analog Electronics

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	L	M							M	S	M
CO2	S	M	L	L	M					M		M	S	M
CO3	M	L											M	L
CO4	S	M	L	L	M							M	S	M
CO5	S	S	M	M	S				S	M	M		S	S
CO6	S	S	M	M	S				S				S	S

Course Assessment Methods:

Direct
• Continuous assessment test • Model Lab Exam • End Semester theory and Practical Exam • Assignments

Course Content:

LINEAR AND NON-LINEAR APPLICATIONS OF OP-AMP **9 Hours**

Basic linear scaling circuits -Voltage amplification and impedance conversion - Voltage summation-Voltage subtraction- current amplification-AC Amplifiers-Non-linear circuits-specific non-linear amplification-synthesized nonlinear response-logarithmic response using nonlinear component-practical logarithmic amplifier. Integrator applications- differentiator applications.

ANALOGUE SIGNAL FILTERS **8 Hours**

Passive filter-LPF-HPF-BPF-BSF, Active filter, Active filter using operational amplifier, choosing frequency response of the low pass filter and high pass filter, sallen-key second order active filter.

ANALOGUE AND DIGITAL CONVERSION **7 Hours**

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General conversion principles and terminology, Digital to analogue conversion-weighted resistor method-R-2R ladder method, Analogue to Digital conversion-Flash ADC-Successive ADC-counter ramp ADC-dual slope ADC-delta sigma charge balance ADC.

RECTIFIER AND SWITCHING REGULATOR **8 Hours**

Rectifier- half wave- full wave- bridge rectifier- filter-ripple reduction techniques -Precision rectifier

Linear regulators-protection circuit- characteristics of linear regulators-Applications of linear regulator. Switching regulator –step down buck- types of switching regulator-PWM controllers.

OSCILLATORS AND RELAYS **8 Hours**

RC Oscillators- RC phase shift- Wien bridge, LC oscillators- Hartley-Colpitts – crystal oscillator.

Relays-basic principles of relays-types of relays-Applications of relays.

PHASE LOCKED LOOP **5 Hours**

Basic principle-phase detector –VCO-Low pass filter-Monolithic phase locked loop-PLL applications.

List of Experiments:

1. Design, simulation and implementation of Op-amp linear application - Voltage summer, voltage subtractor, AC amplifier
2. Design, simulation and implementation of Op-amp nonlinear applications - Sample and Hold circuit, Log and Antilog Amplifier, Multiplier.
3. Design, simulation and implementation of Electronic P, PI and PID controllers using Op-amp.
4. Design and analysis of the Frequency response of second order Butterworth low pass filter and high pass filter.
5. Design and analysis of the Frequency response of second order Universal active filter.
6. Design, simulation and analysis of successive approximation type analog to digital converter.
7. Design, simulation and analysis of R-2R ladder network n type analog to digital converter.
8. Design, simulation and implementation of Half wave, Full wave and Precision rectifiers.
9. Design, simulation and implementation of rectifier with filters.
10. Design, simulation and implementation of DC power supply using LM314 and LM723.
11. Design, simulation and implementation of RC phase shift and Wien bridge oscillator.
12. Design, simulation and implementation of Relay switch circuit.
13. Design, simulation and Analyze the characteristics and application of PLL.
14. Design, simulation and implementation of buck boost PWM controller.
15. Mini project in PCB

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

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Reference Books:

1. Electronic Signal Conditioning Ist Edition, Bruce Newby, imprint by Butterworth Heinemann Ltd, Reed Elsevier Plc Group.
2. Linear integrated circuits, Joseph Carr and Joe Carr, imprint by Newnes Ltd, Elseveir.
3. Op-amps and Linear integrated circuits by Ramakant K Gayakwad, Perason Publications
4. Linear integrated circuits by D Roy Choudhury and Shail B Jain, New age international Publications, 4 th edition.

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U18EII4202 **DIGITAL FUNDAMENTALS AND MICROPROCESSORS**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1:.Summarize the fundamental concepts of number systems and logic gates. (K2)

CO2:. Explain the elements of digital system abstractions such as digital representations of information, digital logic, Boolean algebra, state elements and finite state machines (FSMs). (K4)

CO3: Apply the appropriate truth table from a description of a combinational and sequential logic function. (K3)

CO4: Outline the evolution of Microprocessors and Microcontrollers. (K2)

CO5: Design and simulate the various combinational and sequential circuit operation. (K6)

CO6: Design, construct and develop theoretical device/circuit operation can be implemented in properly constructed digital circuits.(K6)

Pre-requisite: --

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1K2	M		L									M	S	
CO2K3	S	M	L										M	
CO3K3	S	M		L						M		M	S	
CO4K2	M		L							M		M	M	
CO5K5	S	S	S	S	M				S				S	
CO6K6	S	S	S	S	S				S				S	

Course Assessment Methods:

Direct
• Continuous assessment test • Model Lab Exam • End Semester Exam • Assignments

Course Content:

NUMBER SYSTEMS AND CODES **6 Hours**

Number systems – Decimal, binary, octal, hexa-decimal, BCD – number conversions – binary arithmetic – 1s and 2s complement representations and arithmetic – weighted and un- weighted codes – ASCII, Gray and 8421 codes

DIGITAL LOGIC AND LAWS **12 Hours**

Basic gates – AND, OR, NOT – Universal gates – NAND and NOR – special gates – EX- OR and EX-NOR – Boolean algebra – DeMorgan's Laws – Simplification using Boolean algebra – Truth Table representation of logic - Converting Truth-Table into Boolean expressions – Sum-of –Products and Product of Sums forms - - Karnaugh Map – Min terms and Max terms – Logic simplification using Karnaugh maps for 3 and 4 variable functions – Use of don't cares.

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COMBINATIONAL LOGIC CIRCUITS **9 Hours**

Adders – half-adder, full-adder, serial adder, parallel (carry look ahead) , BCD adders – Encoders and decoders – multiplexors and de-multiplexors – parity generators and checkers – magnitude comparator, 7-segment display drivers and decoders

SEQUENTIAL LOGIC CIRCUITS **9 Hours**

Latches and flip-flops – Level and edge triggering - SR, clocked SR, data latches – JK, T and D flip-flops – Excitation table and characteristic equations – asynchronous and synchronous logic – shift registers – universal shift registers – asynchronous, synchronous and modulo counters – Finite state machines – Moore and Mealey models – Introduction to state table, state diagrams and state reduction – Counter design using FSM approach – Sequence detection using Moore and Mealey models.

INTRODUCTION TO MICROPROCESSORS AND MICROCONTROLLERS

9 Hours

Evolution of microprocessors, 4-bit, 8-bit, 16-bit, 32-bit and 64-bit – Von Neumann Architecture – Harvard Architecture – Evolution of microcontrollers – 4-bit, 8-bit, 16-bit and 32-bit - Central processing unit – Memory – RAM and ROM – Interfacing – Serial I/O, Parallel I/O, interrupt I/O and Direct memory access – Need for peripherals – Architectures of 8085 and 8051– Block diagram of 8255 PPI

List of Experiments:

1. Simplification and implementation of Combinational circuits (use of K-map)
2. Arithmetic circuits – Half-adders, full-adders, Carry look-ahead adders, BCD adders, magnitude comparators
3. Sequential circuits – Verification of excitation tables of SR, JK, T and D flip-flops
4. Sequential circuits – Universal shift registers, asynchronous counters, synchronous counters, modulo counters, BCD counters
5. FSM based design – Counters, sequence detectors

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

Reference books:

1. Thomas L. Floyd, “Digital Fundamentals”, 10th Edition, Pearson Education Inc., New Delhi, 2009.
2. A.P. Malvino, D. Leach, G. Saha, “Digital Principles and Applications”, 6th Edition, Tata McGraw Hill Co. Ltd., New Delhi
3. S. Gaonkar, “Microprocessor, Architecture and Programming”, 5th Edition, Penram International Publications Pvt. Ltd.
4. M. A. Mazidi, J. G. Mazidi, “8051 Microcontroller and embedded systems”, 5th Edition, Pearson Education Inc.

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U18EII4203	MODELLING AND ANALYSIS OF DYNAMIC SYSTEMS	L	T	P	J	C
		3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Model any given 1st and 2nd order physical system and analyse the dynamic response.

CO2: Apply the block diagram reduction technique, Signal flow Graph, Bond graph and obtain State space model for the given physical system.

CO3: Analyse the time response for the given system and the steady state error.

CO4: Analyse the stability of the given system using Bode plot, polar plot and Nyquist plot.

CO5: Examine the given physical model using simulation tools.

CO6: Infer and validate the model in Time and Frequency domain.

Pre-requisite --

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

Course Assessment Methods:

Direct **Indirect**

- Continuous assessment test
- Model Lab Exam
- End Semester Exam
- Assignments

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Course Content:

INTRODUCTION TO PROCESS DYNAMICS AND MATHEMATICAL MODELS **12 Hours**

Introduction to Control Systems – Classifications - Review of 1st and 2nd order linear differential equations – Modelling of Mechanical, Thermal, Pneumatic, Hydraulic, Electrical and Electromechanical systems in frequency Domain – State space Modelling - Introduction to z-transform - discrete time system representation using difference equations.

PROCESS SIMPLIFICATION **6 Hours**

Bond Graph – Block Diagram Reduction - Signal Flow graph.

TIME DOMAIN ANALYSIS **9 Hours**

Introduction – Test Signals – First and Second Order Systems – Time Domain Specifications - Representation of process dynamics by 1^{st} and 2^{nd} order transfer functions – Static and Generalised Error Coefficients – Steady state error analysis - Stability criteria for feedback control – Routh-Hurwitz criterion - Root locus diagrams.

FREQUENCY DOMAIN ANALYSIS AND COMPENSATOR DESIGN **9 Hours**

Frequency Domain Specifications - Frequency response plots – Stability Analysis - Bode Plot, Polar Plot, Nyquist Plot – Correlation between time and frequency domain specifications - Lag, Lead, Lag-Lead Compensator Design.

STABILITY ANALYSIS IN DIGITAL DOMAIN **9 Hours**

Bilinear transformation – Jury's stability test - Z domain Nyquist stability.

List of Experiments:

1. Introduction to MatLab Simulink, Control System toolbox, Simscape.
2. Simulation of thermometer, RL / RC, Gear Train using Simscape.
3. Mathematical modelling and simulation analysis of physical systems.
4. State space modelling using simulation.
5. Simulation study of process simplifications.
6. Modelling of Manometer using simulation tool and validation of second order step response.
7. Modelling and Analysis of DC servo motor.
8. Stability Analysis of Linear Systems in Time Domain.
9. Stability Analysis of Linear Systems in Frequency Domain.
10. Compensator design.
11. Case Study: Syncros
12. Mini Project

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

Reference books:

1. Chi-Tsong Chen, Analog and Digital Control Systems Design, Saunders College Publishing, Harcourt Brace Jovanovich college Publishers.
2. Norman S. Nise, Control Systems Engineering, John Wiley & Sons; 7th Edition edition, ISBN-10: 1118170512 ISBN-13: 978-1118170519.
3. Barraclough, B, Dutton, K, Thompson, S 1997, The Art of Control Engineering, Prentice Hall ISBN-13: 978-0201175455.
4. Knovel library: https://app.knovel.com

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MEMS AND SENSOR DESIGN

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Comprehend the fundamental fabrication techniques used in the development of MEMS devices. (K2)

CO2: Recognize the significance of microfabrication in modern technology and its impact on MEMS development. (K4)

CO3: Understand the principles of nanofabrication techniques and the role of cleanroom environments in fabrication processes. (K2)

CO4: Apply the key mechanisms of thin film deposition, lithography, etching, and other fabrication techniques in MEMS manufacturing. (K3)

Pre-requisite: U18EII3202 – Sensors and Measurements

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S							S		S		
CO2	S			M				W		S			M	
CO3	S		M							S		M		
CO4	S		M						M	S		M		

Course Assessment Methods:

Direct
• Continuous assessment test • End Semester Exam • Assignments

Course Content:

INTRODUCTION **9 Hours**

MEMS, Microsystems, Smart systems and nano sensors – smart sensors and actuators - Evolution of MEMS –Approaches to MEMS Design – Successful MEMS Products – Applications - MEMS devices in smart phones - Capacitive Accelerometer, Microphones, BAW resonator and Bimorph actuator.

MICROSYSTEM FABRICATION **9 Hours**

Diffusion, Oxidation, Deposition and Etching - Basic Principles of CVD process – PCVD, metal-organic CVD and Atomic layer CVD (ALD) – Special CVD processes – PVD process – Thermal evaporation and sputtering – Other PVD methods.

MICROSYSTEM MANUFACTURING **9 Hours**

Lithography – UV and Electron beam lithography – Dry Etching – Etching anisotropy – Deep Dry Etching – Ion beam etching – Wet etching – isotropic and anisotropic wet etching – Bulk and surface micromachining – etch stop techniques – super drying.

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DESIGN AND TESTING OF CAPACITIVE ACCELEROMETER **9 Hours**

Quasi-Static Accelerometers - Position Measurement - Circuits -Demodulation - Chopper-Amplifiers – Sampling - Signal-to-Noise Issues - Sensor Design and Modeling - Fabrication and Packaging - Noise and Accuracy – Simulation and parametric testing using CAD tool.

DESIGN AND TESTING OF PIEZORESISTIVE PRESSURE SENSOR **9 Hours**

Hydraulic System: Basics – Hydraulic Fluid Power – Symbols – Electrical Elements – Hydraulic Piezoresistive materials - Longitudinal and Transverse Piezoresistance - Stress and Doping-Fabrication Process Flow - Diaphragm and Piezoresistor dimensions - Stress Analysis Signal - Conditioning and Calibration - Device Noise - Simulation and parametric testing using CAD tool.

Theory Hours: 45	**Total Hours : 45**

Reference Books:

1. Senturia, Stephen D. Microsystem Design, New York Springer, 2004
2. Micro and Nanofabrication (MEMS) edX Mass Online Open Course : https://courses.edx.org/courses/course-v1:EPFLx+memsX+3T2017/course/
3. Madou, Marc. Fundamentals of Microfabrication. Boca Raton, FL: CRC Press, 1998.
4. "Introduction to Microfabrication, Second Edition", Sami Franssila, John Wiley,2010.

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U18EIT4005 ANCILLARY SUPPORT SYSTEMS

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Assess the fundamental principles of EMI/EMC problem identification, design strategies, and preventive measures, including earthing and shielding techniques.(K4)

CO2: Analyze the principles governing power distribution systems and their components.(K4)

CO3: Design and develop wiring diagrams for control panels based on system requirements. (K6)

CO4: Explain the working principles and operation of hydraulic and pneumatic systems. (K2)

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S		S							S		S		
CO2	S			M				W		S			M	
CO3	S		M							S		M		
CO4	S		M						M	S		M		

Course Assessment Methods:

Direct
• Continuous assessment test • End Semester Exam • Assignments

Course Content:

PRACTICAL SHIELDING, EARTHING AND CIRCUIT BOARD LAYOUT OF ELECTRONIC SYSTEMS 9 Hours

Fundamentals of EMI, coupling modes, sources of transients, Fourier representation of EMI - Earthing and shielding principles and practices - LF magnetic shielding, gaskets and sealing, PCB shielding, safety and signal grounds - Cables, connectors and circuits - noise, cable parameters, routing, screening and connectors, stray capacitance and lead inductance.

PROTECTION AND SWITCHGEAR 9 Hours

Power distribution fundamentals - equipment, voltage improvement - Short circuits (common faults, calculations - Switchgear – medium voltage - parameters and operating characteristics, isolators/connectors, circuit breakers, insulation types - Power cables - types, losses, voltage drops, installation, faults.

CONTROL PANEL WIRING 9 Hours

Wiring drawings of control panels - Electrical safety - tools and equipments - Wiring a control panel - Identifying faulty components – Profession skills – Coordination and Communication skills - work place health and safety.

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MOTOR PROTECTION AND CONTROL **9 Hours**

Three phase induction motor – motor technology and construction, energy losses and efficiency – Control and protection - DOL starters – Star/Delta starters – AC variable speed drives - Types of VFD - Soft Starters – DC Servo motors – Speed control for DC motors –Drives for Stepper motor and Servo motor.

HYDRAULICS AND PNEUMATIC SYSTEMS **9 Hours**

Hydraulic System: Basics – Hydraulic Fluid Power – Symbols – Electrical Elements – Hydraulic pumps – Motors and Actuators – Hydraulic valves and System accessories – Hydraulic circuit design.

Pneumatic system: Fundamentals, Construction – Power Transition – FRL units – Actuator – Control Valves – Pneumatic circuits - Electrical elements used in pneumatic circuits.

Theory Hours : 45 **Total Hours : 45**

Reference Books:

1. IDC Technologies, Practical Electrical Wiring Standards (AS 3000:2007), IDC Technologies, Perth.
2. IDC Technologies, Safe Operation & Maintenance of Circuit Breakers and Switchgear, IDC Technologies, Perth.
3. IDC Technologies, Troubleshooting, Maintenance & Protection of AC Electrical Motors and Drives, IDC Technologies, Perth.
4. Electrical System Design – M.K. Giridharan – Amazon.com
5. Advanced Industrial Control Technology – Peng Zhang
6. Cyber security for industrial control SCADA, DCS, PLC, HMI – Tyson Macaulay Bryan L. Singer
7. Electrical motors and Drives – Austin Hughes
8. Hydraulics and Pneumatics a Technician's and Engineer's – Andrew Parr
9. Engineering Application of Pneumatic and Hydraulics – Eurlng lan C. Thrner
10. Hydraulics Basic Level – FESTO
11. Hydraulics Professional – FESTO
12. A Text Book of Electrical Technology Vol 1 & 2 – B.L. Theraja
13. https://app.knovel.com

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U18INI4600 **ENGINEERING CLINICS - 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 team work
- To create an engaging and challenging environment in the engineering lab

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify a practical problems and find a solution

CO2: Understand the project management techniques

CO3: Demonstrate their technical report writing and presentation skills

Pre-requisite: Nil

COs	PO													
	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% 2. Workbook report 10% 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 IV semester, students will focus primarily on Reverse engineering project to 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 tasks, 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.

The progress of the course is evaluated based on reviews and final demonstration of prototype.

Total Hours: 90

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U18VET4101	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY (Common to all UG branches from 2020-2024 batch onwards)	L	T	P	J	C
		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:

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	PSO2
CO1						M	M	M	S			M	-	-
CO2						S	M		S	S		S	-	-
CO3								M	M		W	S	-	-
CO4								S	M		M	M	-	-

COURSE ASSESSMENT METHODS:

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

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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 being 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 tome. 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

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U18INT4000

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 will be able to:

CO 1: Gain Knowledge about the Constitutional Law of India
CO 2: Understand the Fundamental Rights and Duties of a citizen
CO 3: Apply the concept of Federal structure of Indian Government
CO 4: Analyze the Amendments and Emergency provisions in the Constitution
CO 5: Develop a holistic approach in their life as a Citizen of India

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
CO1						M			W			S
CO2						S		S				M
CO3									M	S		W
CO4								W	M			M
CO5						M		M				S

Course Assessment methods

Direct
3. Group Activity / Quiz/ Debate / Case studies 4. Class test / Assignment

THEORY COMPONENT:

Module.1: Introduction to Indian Constitution **4 hours**

Meaning of the constitution law and constitutionalism - Historical perspective of the Constituti and characteristics of the Constitution of India.

Module.2:Fundamental Rights **8 hours**

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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
5. The Constitution of India – Google free material - www.constitution.org/cons/india/const.html
4. Parliament of India – PDF format *download.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 V

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U18EII5201 **PROCESS DYNAMICS AND CONTROL**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify the basic principles & importance of process control in industrial process plants. (K3)

CO2: Develop mathematical models of industrial processes for control system design. (K3)

CO3: Design and fine-tune PID controllers to optimize process performance. (K3)

CO4: Differentiate between various control strategies and analyze their characteristics. (K3)

CO5: Utilize appropriate software tools for modeling plant dynamics and designing control loops. (K4)

CO6: Assess the experimental implementation of process control schemes and critically evaluate methods for process monitoring and diagnosis. (K5)

Pre-requisite: U18EII4203 - Modelling and Analysis of Dynamic Systems.

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

Course Assessment Methods:

Direct Method

- Internal Tests
- Assignment
- Model Lab Exam
- End Semester Theory & Practical Exam

Course Content:

INTRODUCTION **(6 hours)**

Introduction to Process control– Hardware elements of a process control system – Degrees of freedom – Process control implementation – Process control documentation – sample control strategies.

Control Objectives & Benefits – Safety – Environmental protection – Equipment protection – Smooth operation – production rate – product quality – Monitoring & Diagnosis.

MODELLING PROCESS DYNAMICS **(8 hours)**

Review of Modeling - Introduction –Input-Output Models And Transfer Functions - examples - Stirred-tank heat exchanger - CSTR - On/off room aircon system.

Dynamic Behavior of Typical Process Systems - Basic System Elements - Self-Regulation

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Multiple Input-Multiple Output Systems.Empirical Model Identification - An Empirical Model Building Procedure

-
Series

FEEDBACK CONTROL(12 hours)

The Feedback Loop - PID Algorithm - PID Controller Tuning for Dynamic Performance - Stability Analysis and Controller Tuning –Digital Implementation of Process control - Practical Application of Feedback Control - Performance of Feedback Control Systems.

SINGLE-LOOP & MULTI-LOOP (14 hours)

Cascade Control – Feed forward Control - Inferential Control - Level and Inventory Control- Single variable model predictive control – Multiloop control – Interaction and Performance analysis. Control Valve characteristics

PROCESS CONTROL DESIGN (4 hours)

Process Control Design:Definition and Decisions - Managing the Design Procedure**.**

List of Experiments:

1 Process Flow Diagram and P&I Diagram for the laboratory process models
2. Safety and Protection setups application for the laboratory process models
3. Modeling and Analysis of STR
4. Dynamic Modeling, Analysis using simulation and real time implementation of Temperature Process controller
5 Dynamic Modeling, Analysis using simulation and real time implementation of Level Process controller
6 Dynamic Modeling, Analysis using simulation and real time implementation of Flow Process controller
7 Characteristics of Process hardware elements: Control valve with and without positioner
8 Tuning of controllers for any process using open loop methods
9 Tuning of controllers for any process using closed loop methods
10 Design and testing of Feed Forward control system
11 Design and testing of Ratio control system for a given application
12 Design and testing of Split range control system
13 Design and testing of Cascade control system
14 Design and testing of Multi-loop control system
15 Configuring and testing of DCS operated Conical tank system

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

References:

1. Marlin, T. E., " Process Control - Designing Processes and Control Systems for Dynamic Performance", 2nd Edition, McGraw Hill, New York, 2000
2. http://www.pc-education.mcmaster.ca/SampleCourse.html
3. W. Bequette, Process Control: Modelling, Design, and Simulation, Prentice Hall International Series, 2002.
4. Stephanopoulos, G., "Chemical Process Control", Prentice Hall Of India, 2003.
5. Coughnowr, D., "Process Systems Analysis and Control ", 3rd Edition. McGraw Hill, New York, 2008.
6. Process Dynamics and Control by Dale E. Seborg, John Wiley & Sons.

Structures Of Simple Systems – Non - interacting Series - Interacting Series -

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U18EII5202 EMBEDDED MICROCONTROLLERS

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):
After Successful completion of this course, the students will be able to : CO1: Ex**successfully completing this course, the students will be able to :**

CO1: Explain the relationship between microcontroller architecture and embedded system development (K4).
CO2: Develop algorithms for embedded system design.
CO3 Implement serial protocol programming using microcontrollers for data communication. (K3)
CO4: Identify and select the appropriate communication protocol for a given application. (K5)
CO5: Integrate and demonstrate real-time communication interfaces in embedded systems. (K4)
CO6: Implement and utilize protocols for device driver development in embedded applications. (K5)

Pre-requisite: U18EII4202 gital fundamentals and microprocessors.

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

Course Assessment Methods:
Direct
• Internal Tests • Assignment • Model Lab Exam • End Semester Theory & Practical Exam

Course Content:

INTRODUCTION TO ARM ARCHITECTURE AND MCU (9 hours)
Overview of ARM architecture and design -Pipelining- Embedded Code Debugging Tools n Tips - MCU Memory Map - MCU Bus Interfaces- MCU Clocks and Details - MCU Peripheral Clock Control- MCU Vector table- MCU interrupt Design - NVIC - Interrupt handling - MCU Specific Header file- Importance of "Volatile" Keyword

GPIO REGISTERS AND CODE DRIVER (9 hours)
GPIO- GPIO Programming structure and Registers- GPIO Driver Development - Driver header file - GPIO Driver Development- Implementing Init API - GPIO Driver Development. Implementing Read/Write APIs - GPIO driver Code testing. Writing Sample APP- GPIO Interrupt Handling

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UART FUNCTIONAL BLOCK, INTERRUPT HANDLING AND CODE DRIVER (9 hours)
UART Essentials, UART functional block and Peripheral Clock - Communication - Interrupts – Registers - Driver Development: Getting Started. UART Driver Development: Driver Header File - Writing init Function - Writing TX/RX function - Interrupt Handling, UART sample application: Getting ready, UART sample application: Implementation

I2C PROTOCOL FUNCTIONAL BLOCK, INTERRUPTS AND LOGIC ANALYZER(9hours)
I2C Essentials, protocol Operating Modes- Addressing mode, Functional block diagram and Clocks - Interrupts – Peripheral - Registers -Master/Slave Communication.
I2C Driver Development: Getting started-Driver Development: Driver header file - Init Function- Writing TX/RX API - Event Interrupt handling for master, Event Interrupt handling for slave - Error Interrupt Handling - Writing I2C sample application: Getting ready, Writing I2C sample Application: Master Code Testing and Protocol Decoding using logic analyzer.

SPI PROTOCOL FUNCTIONAL BLOCK AND DRIVERS (9 hours)
SPI Essentials - phase, polarity and SPI modes. SPI: Functional Block and Clock, SPI Important Registers. SPI Driver Development - Writing Driver header file. SPI Driver Development: Implementing init API - SPI Master/Slave Communication - SPI Driver Development: Implementing TX/RX API.
(Open Hardware- RISC 5 Processor)

List of experiments

1 To Blink an LED using RPi.

2 a) ADC Interfacing using RPi.

b) Potentiometer Interfacing using RPi.

3 Pulse width modulation using RPi.

4 Serial Communication using RPi.

5 Data Monitoring systems in website using RPi.

6 Data Monitoring systems in mobile app using RPi.

7 GPIO Driver Development and Implementing Read/Write in APIs using STM Controller.

8 Serial Communication interfacing the TX/RX function in UART using STMController.

9 Serial Communication interfacing Interrupt Handling in UART using STM Controller

10 ADC interfacing with UART communication using STMController.

11 Event Interrupt handling for master and slave communication in I2C using STM Controller.

12 SPI Driver Development: Implementing TX/RX API using STMController.

13 Serial Communication Timer interfacing using EEPROM and implement in STM Controller

14 Mini project.

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

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REFERENCES

1. Geoffrey Brown “Discovering the STM32 Microcontroller”.
2. microcontroller peripheral devices and examples of typical by QIU SHI KE JI BIAN ZHU
3. Steve Furber, “ARM System on Chip Architecture” Addison- Wesley Professional Second Edition, Aug 2000.
4. Device Driver Programming by Concurrent Computer Corporation
5. Jason Andrews “Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology)” Newnes, BK and CD-ROM (Aug 2004).
6. P. Rashinkar, Paterson and L.Singh, “System on a Chip Verification – Methodologies and Techniques”, Kluwer Academic Publishers, 2001.
7. David Seal “ARM Architecture reference Manual”, Addison-Wesley Professional;2nd Edition,2001
8. Alan Clement, “The Principle of computer Hardware”, 3rd Edition, Oxford University Press.

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U18EII5203 **FIELD INSTRUMENTATION**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify appropriate measurement techniques for various physical parameters in the process industry. (K3)

CO2: Solve engineering problems related to field instruments and assess their safety and redundancy. (K4)

CO3: Develop Process and Instrumentation (P&I) diagrams for a given unit operation and design transmitters. (K3)

CO4: Analyze and evaluate procedures for calibrating and mounting measuring devices. (K5)

CO5: Select appropriate measuring devices for industrial applications and conduct relevant experiments. (K3)

CO6: Acquire and assess the performance of field instruments using appropriate tools and techniques. (K4)

Pre-requisite: U18EII3202 -Sensors and Transducers

COs	**PO**												**PSO**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
	K3	K4	K5	K5	K3	K3	K3	K3	K3	K3	K3	K3	K4	K4
CO1-K3	S	M	W	W									M	
CO2-K4	S	S	W	W				M					S	
CO3-K3	S	M	W	W	M					M			S	
CO4-K5	W	M	S	S									S	
CO5-K3	S	M	W	W									M	
CO6-K4	S	S	M	M	M								S	

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- Model Lab Exam

End Semester Theory & Practical Exam

Course Content:

LEVEL MEASUREMENT **8Hours**

Introduction level measurement technologies in the process control industry- Categorizing Level Measurement Technologies: Contact and Non-Contact type-Type of Material Measured (liquids, granular solids, slurries, and interfaces)- Contact Sensors : Level Sight Gauge, Float, Displacer, Bubble Tube, RF Capacitance, Resistance Tape, Contacting Ultrasonic; Non-Contact Sensors: Radar, NC Ultrasonic, Load Cells, Nuclear- Mounting techniques- Level sensor accessories in process/instrument, - Analysis stability &safety/redundancy.

Case Study: Boiler drum, Oil separator, Ballast tanks, Gas separators, ***

FLOW MEASUREMENT **12 Hours**

Introduction to flowmeters for process control industry - Differential Pressure Flowmeters, Positive

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Displacement Flowmeters, Turbine Flowmeters, Coriolis Flowmeters,Ultrasonic Flowmeters, Vortex Flowmeters, Thermal Flowmeters, Mounting techniques- flow sensor accessories in process/instrument-Analysis of stability &safety/redundancy. Calibration techniques-Case Study: steam flow, oil flow, air flow, water flow, ***

TEMPERATURE MEASUREMENT **10 Hours**

Introduction to Industrial Temperature Measurement Devices- Resistance Temperature Detectors (RTDs), RTD sensor connections, Self-heating error, Thermocouples, Dissimilar metal junctions, Thermocouple types, Manually interpreting thermocouple voltages, Reference junction compensation, Law of Intermediate Metals, Software compensation, Extension wire, Side-effects of reference junction compensation, Burnout detection, Connector and Tips for Selecting a Thermowell for your Process Application. Non-contact temperature sensors, Concentrating pyrometers, Distance considerations, Emissivity, Thermal imaging, Temperature sensor accessories in process/instrument- Analysis of stability &safety/redundancy.- Case Study: – steam temperature- pulp temperature, CSTR, ***

PRESSURE MEASUREMENT **7 Hours**

Introduction to Industrial Pressure measurement- Mechanical types – Electrical types –Elastic types – Vacuum pressure gauges – DPT –Electronic pressure measurement types- Mounting techniques- Calibration techniques - Pressure sensor accessories in process/instrument- Analysis of stability &safety/redundancy-Case Study: steam pressure, CSTR, ***

FIELD INSTRUMENTS AND DESIGN OF TRANSMITTER'S **8 Hours**

Miscellaneous field instruments and Design of Transmitter's:- Vibration – pH- Density – Conductivity – viscosity-humidity –Design of Two-wire, Three-wire& Four-wire transmitter circuits (Chip Based), Calibration techniques - Instrumentation data sheets- Process Instrumentation diagram (one unit operation case study, ***).

Note:

***** Approach to all the application with PI diagram**

List of Experiments:

1. Dynamic response analysis of Capacitance type level meter
2. Experimental validation of d/p transmitter specifications
3. Experimental validation of mass flow meters.
4. Specification validation of Restriction type flow meters.
5. Design ofcold junction compensation for thermocouple.
6. Design and Analyse the performance of Thermocouple & RTD for a specific Application.
7. Design and Analyse the performance of Piezo resistive pressure Transmitter.
8. Calibration of Pressure gauges as per NABL standards
9. Calibration of Temperature sensor as per NABL standards
10. pH meter standardization and measurement of pH values of solutions with & without Temperature compensation.
11. Measurements of conductivity of test solutions
12. Measurement of absorbance and Transmittance of a given sample using UV spectrophotometer.

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

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Text Books:

1. "Doebelin E.O. and Manik D.N.", Measurement Systems Application and Design, Special Indian Edition,
2. Tata McGraw Hill Education, 2007.
3. "Patranabis",D. Principles of Industrial Instrumentation, 3rdEdition, Tata McGraw Hill, New Delhi, 2010.
4. "Bela G. Liptak", Instrument Engineers' Handbook Fourth Edition, Process Measurement and Analysis Volume I, CRC Press, 2003.
5. "Eckman, D.P.", "Industrial Instrumentation", Wiley Eastern Limited.
6. "Tony R. Kuphaldt", Lessons in Industrial Instrumentation,
7. "R.P Benedict" Fundamentals of Pressure and Flow Measurements, John Wiley & sons.
8. "David W. Spitzer", Industrial Flow Measurement; ISA The Instrumentation, Systems, and Automation Society,01/Jan/2005.
9. Instrumentation for automation and process control http://www.idc-online.com
10. Instrumentation tools.com symbols & standards.

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U18EIT5004 **INDUSTRIAL COMMUNICATION AND NETWORKING**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Analyze the fundamentals of communications (K4).

CO2: Examine the principles of selecting and installing telecommunications systems(K4).

CO3: Make use of "best practice" decisions on the best and most cost-effective access options for an industrial network (K4).

CO4: Identify, prevent and troubleshoot industrial communications problems(K3).

CO5: Test the installation and the configuration of a simple Ethernet network(K3).

CO6: Interpret a protocol through simple implementation (K2).

Pre-requisite: -

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PS02
	K3	K4	K5	K5	K3	K3	K3	K3	K3	K3	K3	K3	K4	K4
CO1(K4)		S												
CO2(K4)		S	M										M	
CO3(K3)	S			S							M	M		
CO4(K4)	M			S						M				
CO5(K3)	S				M		W							S
CO6 (K2)						M								M

Course Assessment Methods:
Direct
• Internal Tests • Assignment/Projects/Reports • End semester exams

Course Content:

BASICS OF COMMUNICATION SYSTEM **2 Hours.**Communication, Communication systems, Modulation, Bandwidth Requirement. Channel Capacity, Baud Rate, Data Rate.

MODULATION TECHNIQUES **10 Hours**

Theory of Amplitude Modulation- Frequency spectrum of AM wave- Representation of AM- Power Relation in the AM wave-Theory of Frequency Modulation- Mathematical Representation of FM- Frequency spectrum of FM wave-Theory of Phase Modulation- Comparison of different modulations-Modulation for Digital signal: Introduction- modulation circuit- demodulation circuit- ASK- FSK- PSK- PWM- PAM- PPM

FUNDAMENTALS OF DATA COMMUNICATIONS **6 Hours**

Bit- Bytes and Characters- Communication principle- Communication modes- Synchronous and

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asynchronous system- Error detection- Transmission Characteristics- Data coding- UART- Functional Layered Models - OSI reference model- System engineering approach- Input / Output Structures- Control Unit Structure- Protocols- Basics of Network Topology

INDUSTRIAL COMMUNICATIONS STANDARDS AND PROTOCOLS 8 Hours

Serial Communication Standards: Serial data communication interface standards- Balanced and unbalanced transmission lines- RS 232-422-485 standards. Troubleshooting serial data communication circuits- Test equipment- RS 422 Standard- RS 485 Standard- Troubleshooting and testing with RS 485- 20 mA Current loop- GPIB- USB.Controller Area Networks (CAN) protocol

Industrial Protocols: XON/OFF Signaling- Binary Synchronous Protocol (BSC)- HDLC/SDLC protocol- CSMA/CD- CA protocol- OSI implementation for Industrial communications- Industrial control applications: ASCCII-based protocol – ANSI –X 3.28 -2.5.

HART COMMUNICATION PROTOCOL 9 Hours

Architecture - physical- data link- application layer- communication technique- normal and burst mode of communication- benefits of HART. Introduction to Wireless HART

OPEN INDUSTRIAL FIELDBUS AND DEVICENET SYSTEMS 10 Hours

Industrial Ethernet: 10Mbps- 100Mbps Ethernet- Gigabit Ethernet- Industrial Ethernet. **Foundation fieldbus:** Fieldbus requirement- features- advantages- fieldbus components- types- architecture–physical- data link- application layer- system and network management- wiring- segment functionality checking- function block application process.

Profibus: Architecture- OSI-model- PROFIBUS types – PA- DP & FMS and their comparison- Designing PROFIBUS- Network design- Advantages and Applications of PROFIBUS in industries**.**

Downstream Communication

OPCUA

Theory Hours: 45	Practical Hours: 0	Total Hours: 465

References Books:

1. Kennedy and Devis- Electronic Communication Systems
2. John Park, Steve Mackay, Edwin Wright, Practical Data Communications for Instrumentations and Control, 1 st Edition ELSEVIER, 2003.
3. Deon Reynders, Steve Mackay, Edwin Wright, Practical Industrial Data Communications, 1 st Edition ELSEVIER, 2005.
4. Behrouz A. Forouzan, Data Communications and Networking, 2nd Edition, Mc Grow – Hill, 2001
5. Lawrence M. Thompson and Tim Shaw, Industrial Data Communications 5thEdition ,ISA

List of Open Source Software/learning website:

Learning website: -

- http://nptel.iitm.ac.in/courses.php
- http://ocw.mit.edu
- http://www.electrical-engineering-portal.com
- http://en.wikipedia.org
- https://www.anlog.com
- https://www.protocols.com
- https://www.cse.wustl.edu/~lu/cse521s/Slides/wirelesshart.pdf

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U18EIT5005 **INSTRUMENTATION AND CONTROL FOR PROCESS INDUSTRIES**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Ability to understand common unit operations in process industries

CO2: Ability to select appropriate measurement techniques for selective processes.

CO3: Ability to select controller structure based on the process knowledge.

CO4: Ability to understand the operation and challenges in integrated industrial processes.

Pre-requisite: -

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PS02
	K3	K4	K5	K5	K3	K3	K3	K3	K3	K3	K3	K3	K4	K4
CO1(K4)	S													
CO2(K4)		S									M			
CO3(K3)														
CO4(K4)		S		S	S								S	S

Course Assessment Methods:
Direct
• Internal Tests • Assignment/Projects/Reports End semester exams

Course Content:

COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -I 9

Unit Operation, Measurement and Control :-Transport of solid, liquid and gases - Evaporators– Crystallizers-Dryers.

COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -II 9

Unit Operation, Measurement and Control :- Distillation – Refrigeration processes – Chemical reactors.

PROCESS MEASUREMENT AND CONTROL INPETROCHEMICAL INDUSTRY 9

Process flow diagram of Petro Chemical Industry - Gas oil separation in production platform – wet gas processing – Fractionization Column – Catalytic Cracking unit – Catalytic reforming unit.

PROCESS MEASUREMENT AND CONTROL IN THERMAL POWERPLANTINDUSTRY 9

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Process flow diagram of Coal fired thermal Power Plant– Coal pulverizer - Deaerator – Boiler drum - Superheater – Turbines.

PROCESS MEASUREMENT AND CONTROL IN PAPER &PULP INDUSTRY 9

Process flow diagram of paper and pulp industry – Batch digestor – Continous sulphate digestor – Control problems on the paper machin

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

References Books:

1. Waddams, A.L., "Chemical from Petroleum", Butter and JannerLtd.,1968.
2. Liptak B.G., "Instrument and Automation Engineers' Handbook: Process Measurement and Analysis", Fifth Edition, CRC Press, 2016.
3. Balchan.J.G., and Mumme K.I., "Process Control Structures and Applications", Van Nostrand Reinhold Company, New York, 1988.
4. Austin G.T and Shreeves, A.G.T., "Chemical Process Industries", McGraw–Hill International student, Singapore, 1985.

List of Open Source Software/learning website:

Learning website: -

http://nptel.iitm.ac.in/courses.php

http://ocw.mit.edu

http://www.electrical-engineering-portal.com

http://en.wikipedia.org

https://www.anlog.com

https://www.protocols.com

https://www.cse.wustl.edu/~lu/cse521s/Slides/wirelesshart.pdf

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SEMESTER VI

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U18EII6201 **INDUSTRIAL AUTOMATION**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):
After Successful completion of this course, the students will be able to :
CO1:Apply the design aspects of industrial automation. K3
CO2: Build PLC program and logic controllers with case study. K3
CO3: Develop PLC diagram &implement the Automation technique used in Industry.K3
C04: Solve engineering problems for Field Automation and analyse their safety/redundancy. K4
CO5: Distinguish appropriate Input/output devices & schemes for industrial automation applications and conduct experiments & analyse their performances. K4
CO6: Develop communication protocol for a typical Field Automation network Architecture. K3

Pre-requisite: U18EII5201Process Dynamics and Control
U18EII5203Field Instrumentation

COs	**PO**												**PSO**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
	K3	K4	K5	K5	K3	K3	K3	K3	K3	K3	K3	K3	K4	K4
CO1-K3	S	M	W	W										
CO2- K3	S	M	W	W	S				M	M			M	
CO3-K3	S	M	W	W	S			W					S	S
CO4-K4	M	S	M	M	S								S	S
CO5-K4	M	S	M	M					S	S			S	S
CO6-K3	S	M	W	W									S	S

Course Assessment Methods:

Direct	**Indirect**
• Internal Tests • Assignment • Model Lab Exam • End Semester Theory & Practical Exam	• Course Exit Survey

Course Content:

DESIGN ASPECTS OF INDUSTRIAL AUTOMATION **9 Hours**

Detailed study of process sequences – preparation of input and output list –Preparation of Schemes (open loop, closed loop, hardwire control, interface) – Input / output signal ranges (Voltage, Current, Pulse) - hardware Selection procedure.

PROGRAMMABLE LOGIC CONTROLLERS **9Hours**

Overview, Functions & Features, - Typical areas of application – Relay & Relay Logics- PLC

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vs dedicated controllers – PLC Architecture & Hardware – System Configuration – Power requirement calculation– Redundancy in power supply system – choice of circuit breakers – control panel & common wiring practices.

PLC PROGRAMMING (FUNDAMENTALS) 9 Hours

PLC Programming Languages – System bits & words – Logic functions – Latch and Memory concepts – Timers & Counter concepts – Basic programming using concepts

PLC PROGRAMMING (FUNCTIONS) 9 Hours

Arithmetic functions – compare functions – converter functions – Data transfer instructions – Function blocks – PID Function Blocks - Different types of programming sequences (Manual, Auto & Alarm) – Operator Level Interfacing unit (HMI) – HMI Programming.

Applications:

Binder-Processing Machine, Crystal Measurement, Smart Bench, Sagger Load Station, Tray Handlers & Cotton Classing System

INTRODUCTION TO SCADA 9 Hours

Introduction to SCADA – SCADA Architecture – Concept of DCS – DCS Architecture – DCS Configuration and Programming – Communication Protocol – Typical Network architecture – Plant network design – Network field instruments-(with case study-using SCADA & Centum VP DCS)

List of Experiments:

1. Study of basic control function in PLC
2. Implementation of logic gates and Boolean functions.
3. Implementation of PLC timer functions.
4. Implementation of PLC counters functions
5. Emulation and Graphical Control.
6. Implementation of PID LOOPS using PLC.
7. Motor control using PLC.
8. Sequential lighting of bulbs.
9. Implementation Automatic Traffic control system.
10. Implementation of sequencer.
11. Develop communication Protocol for a typical Field Automation Network Architecture.

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

References:

1. "Frank Lamb ", Industrial Automation Hands-On, 2013 by McGraw-Hill Education. ISBN: 978-0-07-181645-8.

2. "StamatiosManesis& George Nikolukopo", Introduction to Industrial Automation, CRC press, Taylor &Fancis, 2018.

3."Hugh Jack" Automatic Manufacturing Systems with PLCs, 2007; www.PAControl.com

4. "Frank D. Petruzella" Programming Logic Controllers.

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U18EII6202 **DIGITAL SIGNAL PROCESSING AND DEEP LEARNING**

L	T	P	J	C
3	0	2	0	4

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Explain the characteristics of discrete-time signals and discrete systems. (K2)

CO2: Use appropriate mathematical tools to evaluate signal and system properties. (K4)

CO3: Demonstrate efficient Discrete Fourier Transform (DFT) computation. (K3)

CO4: Discuss the advanced features and architecture of generic programmable digital signal processors (P-DSP). (K4)

CO5: Implement algorithms for digital signal processing systems. (K3)

CO6: Design Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters for signal processing applications. (K6)

Pre-requisite: U18EII4203- Modelling and Analysis of Dynamic Systems.

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M													
CO2		S											S	
CO3			S											S
CO4	S													
CO5				S										
CO6	M													

Direct
• Internal Tests • Assignment • Model Lab Exam • End Semester Theory & Practical Exam

Course Content:

DISCRETE TIME SIGNALS AND SYSTEMS **9 Hours**

Representation of a CT signal by samples – Sampling theorem – Reconstruction of a signal from its samples – Aliasing – DT Signals – Impulse, Step, Pulse, Sine, Exponential – Properties of DT signals - Transformation of independent variable – Shifting, scaling, folding - Discrete Time LTI systems – Properties – Impulse response – Convolution sum – Properties of Convolution

Z-TRANSFORM AND SYSTEM ANALYSIS **9 Hours**

DTFT – Properties - Z transform – Forward Transform - Inverse Transform using Partial Fractions - Properties – Pole-Zero plot – Difference Equations - Transfer function - Analysis of Discrete Time systems using DTFT and Z Transform.

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DISCRETE FOURIER TRANSFORM **9 Hours**

Introduction to DFT– Properties of DFT – Efficient computation of DFT – FFT algorithms – Introduction to Radix-n algorithms - Radix-2 FFT – Decimation-in-Time and Decimation–in-Frequency algorithms – Butterfly diagram.

DESIGN OF DIGITAL FILTERS **9 Hours**

FIR filter design: Linear phase characteristics - Windowing Technique –Rectangular, Hamming, Hanning, Blackmann windows – IIR filter design: Analog filter design - Butterworth and Chebyshev approximations – Impulse invariance and Bilinear transformations - FIR and IIR filter structures – Direct form I and II - cascade and parallel forms – Finite Precision effects.

ADVANCED TOPICS IN DSP AND MACHINE LEARNING **9 Hours**

Concepts of multi-rate signal processing – Decimation and interpolation by integer factor – Sampling rate conversion – Introduction to DSP architecture - Harvard, Modified Harvard architectures –Machine learning – AI revolution – Block chain – Using AI to augment human intelligence.

List of Experiments:

1 Matlab Primer – 1D and 2D array manipulations
2 Signal generation and sampling analysis
3 Audio signal – Frequency domain analysis
4 Audio capture and processing
5 Design of filters – FIR
6 Design of filters - IIR
7 Noise removal using filtering of audios
8 Implementation of simple neural networks
9 Implementation of neural networks with hidden layers
10 Simple regression applications.

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

References:

1. Mrinal Mandel and Amir Asif, “Continuous and Discrete Time Signals and Systems”, Cambridge International Student Edition, Cambridge University Press, 2007.
2. Leonard Eddison, “Machine Learning – A technical approach to machine learning for beginners”, 2017
3. JohnG.ProakisandDimitrisG.Manolakis, “DigitalSignalProcessing,Principles AlgorithmsandApplications”,PHI, 3rdEdition.2000.
4. B. Venkataramani, M. Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications”, Tata McGraw Hill, New Delhi, 2003. (Unit V)
5. JohnyR.Johnson,“IntroductiontoDigitalSignalProcessing”,PHI, 2009.
6. Won Y. Yang et. Al., “Signals and Systems with MATLAB”, Springer International Edition, 2009
7. Steven W. Smith, “The Scientists and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing, 1997.
8. James H. McClellan, Ronald W. Schafer, Mark A. Yoder, “Signal Processing First”, 2nd Edition

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U18EIT6003 **COMPREHENSIVE STUDIES**

L	T	P	J	C
2	0	0	0	2

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Apply engineering mathematics and electrical circuit principles to solve relevant problems. (K3)

CO2: Analyze and solve problems related to signals and systems, analog electronics, and control systems. (K3)

CO3: Apply knowledge of digital electronics, measurements, sensors, and industrial instrumentation to solve practical problems. (K3)

CO4: Solve problems in communication systems and optical instrumentation using appropriate methodologies. (K3)

Pre-requisite: U18EII3201, U18EII3202, U18EII4202 U18EII5201, U18EII5203

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M		S	M								M	
CO2	M	M		M									M	
CO3	W		M										M	
CO4	M	M		W										M

Course Assessment Methods:
Direct
• Internal Tests • Assignment • End Semester Theory Exam

Course Content:

SECTION 1: ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, systems of linear equations, Eigen values and Eigen vectors.
Calculus: Mean value theorems, theorems of integral calculus, partial derivatives, maxima and minima, multiple integrals, Fourier series, vector identities, line, surface and volume integrals, Stokes, Gauss and Green's theorems.
Differential equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of parameters, Cauchy's and Euler's equations, initial and boundary value problems, solution of partial differential equations: variable separable method.
Analysis of complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent's series, residue theorem, solution of integrals.
Probability and Statistics: Sampling theorems, conditional probability, mean, median, mode and standard deviation, random variables, discrete and continuous distributions: normal, Poisson and binomial distributions.

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Numerical Methods: Matrix inversion, solutions of non-linear algebraic equations, iterative methods for solving differential equations, numerical integration, regression and correlation analysis.
Instrumentation Engineering

SECTION 2: ELECTRICAL CIRCUITS:
Voltage and current sources: independent, dependent, ideal and practical; v-i relationships of resistor, inductor, mutual inductor and capacitor; transient analysis of RLC circuits with dc excitation.
Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer and reciprocity theorems.
Peak-, average- and rms values of ac quantities; apparent-, active- and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, locus diagrams, realization of basic filters with R, L and C elements.
One-port and two-port networks, driving point impedance and admittance, open-, and short circuit parameters.

SECTION 3: SIGNALS AND SYSTEMS
Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, frequency response of first and second order linear time invariant systems, impulse response of systems; convolution, correlation. Discrete time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

SECTION 4: CONTROL SYSTEMS
Feedback principles, signal flow graphs, transient response, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems; mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on-off, P, P-I, P-I-D, cascade, feedforward, and ratio controllers.

SECTION 5: ANALOG ELECTRONICS
Characteristics and applications of diode, Zener diode, BJT and MOSFET; small signal analysis of transistor circuits, feedback amplifiers. Characteristics of operational amplifiers; applications of opamps: difference amplifier, adder, subtractor, integrator, differentiator, instrumentation amplifier, precision rectifier, active filters and other circuits. Oscillators, signal generators, voltage controlled oscillators and phase locked loop.

SECTION 6: DIGITAL ELECTRONICS
Combinational logic circuits, minimization of Boolean functions. IC families: TTL and CMOS. Arithmetic circuits, comparators, Schmitt trigger, multi-vibrators, sequential circuits, flip-flops, shift registers, timers and counters; sample-and-hold circuit, multiplexer, analog-to-digital (successive approximation, integrating, flash and sigma-delta) and digital-to-analog converters (weighted R, R-2R ladder and current steering logic). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time); basics of number systems, 8-bit microprocessor and microcontroller: applications, memory and input-output interfacing; basics of data acquisition systems.

SECTION 7: MEASUREMENTS
SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors. PMMC, MI and dynamometer type instruments; dc potentiometer; bridges for measurement of R, L and C, Q-meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters,

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voltage and current scaling, instrument transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding.

SECTION 8: SENSORS AND INDUSTRIAL INSTRUMENTATION

Resistive-, capacitive-, inductive-, piezoelectric-, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (differential pressure, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement.

SECTION 9: COMMUNICATION AND OPTICAL INSTRUMENTATION

Amplitude- and frequency modulation and demodulation; Shannon's sampling theorem, pulse code modulation; frequency and time division multiplexing, amplitude-, phase-, frequency-, pulse shift keying for digital modulation; optical sources and detectors: LED, laser, photo-diode, light dependent resistor and their characteristics; interferometer: applications in metrology; basics of fiber optic sensing.

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

Refences :

1. GATE Solved Papers for Instrumentation (IN)
2. Guidebook for Gate Instrumentation Engineering.

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SEMESTER VII

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U18EIT7001	ANALYTICAL INSTRUMENTATION	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 interaction of electromagnetic radiation with matter and apply analytical techniques to determine elemental composition in each sample accurately. (K2)

CO2: Select appropriate instruments for specific analyses while considering their merits, demerits, and limitations. (K3)

CO3: Utilize various instrumental methods for chemical analysis in different applications. (K3)

CO4: Assess and analyze hazardous materials, environmental samples, and inorganic, organic, and biomaterials at trace and ultra-trace levels. (K4)

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1 (K2)	S	L												
CO2 (K3)	S	M	M		M								M	
CO3 (K3)	S	M	M		M				M	M	M		M	
CO4 (K4)	S	M	M		M								M	

S-Strong M-Medium L-Low

Course Assessment methods:

Direct
Continuous assessment tests Assignments Lab exam End Semester Exam

Course content

Introduction to analytical systems & Spectroscopy principles: 9 Hrs

Introduction to composition measurement and process analyzers. Importance of analytical instrumentation for continuous on-line measurement.

Electromagnetic spectrum. Sources and monochromators. UV/visible sources (Deuterium lamp, tungsten lamp), Infrared sources (Globar lamp, Nernst lamp), X rays sources (Coolidge tube), prism and gratings (Echelette grating), Detectors and transducers (Photodiode,

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photomultipliers, silicon diode, thermocouple, thermistor, Geiger-Muller tube, Ionization chamber).

UV, Visible spectroscopy & Infrared spectroscopy 9 Hrs

UV/visible spectrophotometer, Beer-Lambert law, Technical vocabulary, spectra, analysis, Instrumentation limits and deviation from the Beer-Lambert law. Examples of UV/visible spectra. Single beam and double beam (spatial, temporal) spectrophotometer.
Infrared spectrometers (Dispersive and Fourier Transform Infrared (FTIR)), Samples preparation. Analysis and FTIR spectra.

Radiochemical and Magnetic resonance technique 9 Hrs

Nuclear radiations – Detectors – GM counter – Proportional counter – Solid state detectors – Gamma cameras – X-ray spectroscopy – Detectors – Diffractometers – Absorption meters – Detectors. NMR – Basic principles – NMR spectrometer – Applications. Mass spectrometers – Different types – Applications.

Chromatography and Surface characterization by Spectroscopy & Microscopy 9 Hrs

Different techniques – Gas chromatography-basic and with multiple columns – Detectors-Applications in environmental analysis, – High-pressure liquid chromatographs – Applications, Introduction to the study of surfces, Electron Spectroscopy, Surface photon spectroscopic methods, Electron- Stimulated Microanalysis methods & Scanning Probe microscope.

Industrial gas analyzers and pollution monitoring instruments 9 Hrs

Types of gas analyzers – Oxygen-micro fuel cells, NO_2 and H_2S types, Luft detectors with flow sensor, filter cells, Continuous emission monitoring system (CEMS), thermal conductivity analyzers. Air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide estimation – Dust and smoke measurements, pH measurement.

Theory: 45 Hrs. Total hrs. 45 hrs.

1. Douglas A. Skoog, F. James Holler, Timothy A. Nieman "Principles of Instrumental Analysis" , Cengage Learning; 6th Edition, 2006,
2. Francis Rouessac, Annick Rouessac, "Chemical Analysis", 2002
3. H.H.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, 'Instrumental methods of analysis', CBS publishing & distribution, 1995.
4. R.S. Khandpur, 'Handbook of Analytical Instruments', Tata McGraw Hill publishing Co. Ltd., 2003
5. Douglas A. Skoog, D. M. West, F. J. Holler "Analytical Chemistry". 7th Edition, 1996.
6. Robinson, James W., "Undergraduate instrumental analysis", 1995

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U18EII7202	ADVANCED CONTROL SYSTEMS	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: Acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers. (K4)

CO2: Analyse non-linear system behaviour by phase plane and describing function methods. (K4)

CO3: Perform stability analysis of non-linear systems. (K4)

CO4: Evaluate performance measures for optimal control problem and design a robust control system. (K4)

CO5: Demonstrate the state space analysis of the given system using simulation tools. (K4)

CO6: Demonstrate non-linear system analysis. (K4)

Pre-requisite courses:

1. U18EII4203 - Modelling and Analysis of Dynamic Systems

CO/PO Mapping

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

COs	Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)													
	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5 (K6)	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1 (K4)	PSO2 (K4)
CO1 (K4)	M	S	M	M									M	
CO2 (K4)	M	S	M	M									M	
CO3 (K4)	M	S	M	M									M	
CO4 (K4)	M	S	M	M									M	
CO5 (K4)	M	S	M	M	S			M	M	M		W	M	
CO6 (K5)	W	M	S	S	S			M	M	M		W	M	

Course Assessment methods:

Direct
Continuous assessment tests Assignments Lab exam End Semester Exam

Course Content:

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STATE SPACE ANALYSIS **12 Hrs**

State space analysis of continuous and discrete systems – solution of time invariant autonomous systems, forced system – state transition matrix – relationship between state equations and transfer function – properties of state transition matrix – computation of state transition matrix - controllability / observability criteria – controller / observer design by state feedback based on pole placement – design of state feedback control systems – full-order and reduced-order observer design.

PHASE PLANE ANALYSIS **12 Hrs**

Concept of phase portraits – singular points – limit cycles – construction of phase portraits – phase plane analysis of linear and non-linear systems – isocline method – delta method.

DESCRIBING FUNCTION ANALYSIS **12 Hrs**

Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems – conditions for stability – stability of oscillations.

STABILITY ANALYSIS **12 Hrs**

Introduction – Lyapunov's stability concept – Lyapunov's direct method – Lure's transformation – Aizerman's and Kalman's conjecture – Popov's criterion – circle criterion.

OPTIMAL AND ROBUST CONTROL SYSTEM DESIGN **12 Hrs**

Optimal control: Introduction- Performance measures for optimal control problem – Linear Quadratic Regulator – linear quadratic tracking problem – optimal estimation – Kalman filter.

Robust control: Introduction – norms of vectors and matrices – norms of systems – H_2 optimal controller – H_2 optimal estimation – $H\infty$ controller – $H\infty$ estimation.

Theory: 45 Hrs **Tutorial: 15 Hrs** **Total Hrs: 60**

List of Experiments

(Simulation Tools: MATLAB / LabVIEW)

1. Developing a state model for a second order system cascaded with active lead circuit and finding its step response and impulse response.
2. Determination of Eigen values of the state model and to convert the state model into transfer function.
3. Transformation of the state model to controllable canonical and diagonal forms.
4. Controllability and Observability Tests.
5. Design of state feedback controller and full state observer.
6. Plotting phase portraits of the system having stable / unstable nodes and focus.
7. Plotting phase portraits of the system having vortex and saddle points.
8. Demonstration of limit cycles for Vanderpol's equation.
9. Demonstration of effect of non-linearities.
10. Stability analysis using describing function method.
11. Liapunov's stability analysis.
12. Design of exact feedback linearizing controller for a non-linear system.

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13. Design of a robust control system.
14. Design of an optimal control system.

REFERENCES

1. Katsuhiko Ogata, 'Modern Control Engineering', Prentice Hall of India Pvt. Ltd., New Delhi, 5th Edition, 2010.
2. Franklin, G. F., David Powell, J, Emami-Naeini, A, 'Feedback Control of Dynamic Systems', Prentice Hall, 7th Edition, 2014.
3. Gopal M, 'Modern Control System Theory', New Age International, 3rd Edition 2014.
4. Dorf R. C, Bishop, R. H, 'Modern Control Systems', Prentice Hall, 13th Edition, 2016.
5. Brogan W. L, 'Modern Control Theory', Prentice Hall, 3rd Edition, 1990.
6. Rolan S. Burns, 'Advanced Control Engineering', Butterworth-Heinmann, A division of Reed Educational and Professional Publishing Limited, Oxford, 2001.
7. Norman S. Nise, 'Control Systems Engineering', John Wiley & Sons Private Limited, 2013.
8. Hassan K. Khalil, 'Nonlinear Systems', Prentice – Hall PTR, 2013.
9. Jean-Jacques Slotine and Weiping Li, 'Applied Nonlinear Control', Prentice Hall, 2005.
10. Sastry S, "Nonlinear Systems: Analysis, Stability, and Control", Springer 2013.
11. Nagrath J and Gopal M, 'Control System Engineering', New Age International Publishers, 6th Edition, 2018.
12. George J. Thaler, 'Automatic Control Systems', Jaico Publishing house, 1993.
13. Ronald R. Mohler, 'Non-linear Systems, Vol. – I, Dynamics & Control', Pearson Education, 1998.
14. Benjamin C. Kuo, 'Automatic Control Systems', Wiley India, 9th Edition, 2014.
15. Ganesh C, Shanmugasundaram R, Mayurappriyan P S, 'Principles of Control Systems', Yes Dee Publishing Limited, India, 2020.

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U18MBT7000	ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course outcomes

After successful of the course, the student would be able to:

CO1: Evaluate the economic theories, cost concepts and pricing policies

CO2: Analyze the market structures and integration concepts

CO3: Apply the concepts of national income and understand the functions of banks and concepts of globalization

CO4: Apply the concepts of financial management for project appraisal and working capital management

CO5: Understand accounting systems

CO6: Analyze financial statements using ratio analysis

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			M
CO2				M		M					M			M
CO3						M					M			M
CO4				M							S			M
CO5											S			M
CO6		M		M							S			M

Course Assessment methods:

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

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 – Marginal Costing – Total Cost – Elements of Cost – Cost curves – Breakeven point and breakeven chart – 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.

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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 bank – 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 :45 hours **Total: 45 hours**

References:

1. Prasanna Chandra, "Financial Management (Theory & Practice)", Tata Mcgraw Hill Publishing Co Ltd, 2016.
2. Weston & Brigham, "Essentials of Managerial Finance", The Dryden Press; Fifth Edition edition (1974)
3. Pandey, I. M., "Financial Management"
4. Fundamentals of Financial Management- James C. Van Horne.
5. Bhaskar S. "Engineering Economics and Financial Accounting", (2003) Anuradha Agencies, Chennai
6. Financial Management & Policy -James C. Van Horne
7. Management Accounting & Financial Management- M. Y. Khan & P. K. Jain
8. 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 Maheswari 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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U18EIP7703	DESIGN 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: Utilize industry-accepted process control and automation practices to optimize system performance. (K3)

CO2: Implement emerging technologies to analyze, design, and maintain reliable, safe, and cost-effective industrial solutions. (K4)

CO3: Exhibit teamwork and effective communication skills in professional and collaborative environments. (K3)

CO4: Comprehend and adhere to industry standards and best practices used in industrial settings, research organizations, and in-house research projects (K3)

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1 (K2)	S	S	S	M	S			S				S		S
CO2 (K3)			S	S	S	M	S	S				S	S	
CO3 (K3)								S	S	S	M	S	S	
CO4 (K4)			M	M	M	M		S		M	S	S		S

S-Strong M-Medium L-Low

Course Assessment methods:

Direct
Project Reviews Viva Project Demo

GUIDELINES

1. Selection of a topic or project title in consultation with a faculty member.
2. Develop a project planning strategy.
3. If it is an industry – sponsored project, a concurrent letter from industry is required.
4. A maximum of 3 students per group will do the project.
5. The project may be done in one of the labs under the supervision of a guide or in the selected

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industry.

6. Continuous assessment of the project will be done by the project review committee based on four reviews consisting of technical presentation.

7. At the end of the project, a report will be written and a technical presentation along with demonstration will be made by the students.

8. The report, project demonstration and technical presentations will be evaluated by the internal and external examiners.

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U18VEP7507 **GLOBAL VALUES**
(Mandatory)

L	T	P	J	C
0	0	2	0	0

Course Outcomes

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

CO 1: Aware of the concept of Universal Brotherhood and support the organizations which areworking for it

CO 2: Follow the path of Ahimsa in every aspect of their life

CO 3: Uphold the Universal declaration of Human Rights

CO 4: Understand the unequal distribution of wealth in the World and bestow their efforttowards inclusive growth

CO 5: Sensitize the environmental degradation and work for the sustainable development

CO 6: Amalgamate harmony through Non-violence and edify the nation headed for upholdingdevelopment

Pre-requisites :

1. U18VEP1501 / PERSONAL VALUES
2. U18VEP2502 / INTERPERSONAL VALUES
3. U18VEP3503 / FAMILY VALUES
4. U18VEP4504 / PROFESSIONAL VALUES
5. U18VEP5505 / SOCIAL VALUES
6. U18VEP6506 / NATIONAL VALUES

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				
CO3									M			
CO4						S						
CO5											M	
CO6												S

Course Assessment methods

Direct
1. Group Activity / Individual performance and assignment 2. Assessment on Value work sheet / Test
Indirect
1. Mini project on values / Goodwill Recognition

Values through Practical activities:

1. Universal Brotherhood : Meaning of Universal Brotherhood- Functioning of Various organization for Universal human beings -Red Cross, UN Office for Humanitarian Affairs – Case study on humanitarian problems and intervention - Active role of Students/Individual on Universal Brotherhood.

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2. Global Peace, Harmony and Unity : Functions of UNO - Principal Organizations - Special organization – Case study relating to disturbance of world peace and role of UNO – Participatory role of Students/Individual in attaining the Global peace and Unity.
3. Non-Violence : Philosophy of nonviolence- Nonviolence practiced by Mahatma Gandhi – Global recognition for nonviolence - Forms of nonviolence - Case study on the success story of nonviolence– Practicing nonviolence in everyday life.
4. Humanity and Justice: Universal declaration of Human Rights - Broad classification - Relevant Constitutional Provisions– Judicial activism on human rights violation - Case study on Human rights violation– Adherence to human rights by Students/Individuals.
5. Inclusive growth and sustainable development : Goals to transform our World: No Poverty - Good Health - Education – Equality - Economic Growth - Reduced Inequality – Protection of environment – Case study on inequality and environmental degradation and remedial measures.

Workshop mode

REFERENCES

1. TEACHING ASIA-PACIFIC CORE VALUES OF PEACE AND HARMONY – UNICEF www.unicef.org/.../pdf/Teaching%20Asia-Pacific%20core%20values.pdf

2. THREE-DIMENSIONAL ACTION FOR WORLD PROSPERITY AND PEACE- IIM Indore - www.iimidr.ac.in/.../Three-Dimensional-Action-for-World-Prosperity-and-Peace-Glo...

3. MY NON-VIOLENCE - MAHATMA GANDHI
www.mkgandhi.org/ebks/my_nonviolence.pdf

4. HUMAN RIGHTS AND THE CONSTITUTION OF INDIA 8th ... - India Juris
www.indiajuris.com/uploads/.../pdf/l1410776927qHuman%20Rights%20080914.pdf

5. THE ETHICS OF SUSTAINABILITY – Research Gate
www.researchgate.net/file.PostFileLoader.html?id...assetKey..

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SEMESTER VIII

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U18EIP8701	CAPSTONE PROJECT	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: Apply fundamental concepts of Electronics and Instrumentation to develop innovative solutions. (K3)

CO2: Design and develop a model or prototype based on an idea related to the field of Electronics and Instrumentation. (K6)

CO3: Work individually or collaboratively to identify, troubleshoot, and build solutions addressing environmental and societal challenges. (K4)

CO4: Conduct surveys and research to develop products that contribute to lifelong learning and technological advancement. (K5)

Pre-requisite: U18EIP7703

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1 (K2)		S	M	M	S			S				S		S
CO2 (K3)	S		S	M	S	M	S	S				S	S	
CO3 (K3)	S			M				S	S	S	M	S	S	
CO4 (K4)			M	S	M	S		S		M	S	S		S

S-Strong M-Medium L-Low

Course Assessment methods:

Direct
Project Reviews
Viva
Project Demo

GUIDELINES

1. Selection of a topic or project title in consultation with a faculty member.
2. Develop a project planning strategy.
3. If it is an industry – sponsored project, a concurrent letter from industry is required.
4. A maximum of 3 students per group will do the project.
5. The project may be done in one of the labs under the supervision of a guide or in the selected industry.
6. Continuous assessment of the project will be done by the project review committee based on four reviews consisting of technical presentation.
7. At the end of the project, a report will be written and a technical presentation along with demonstration will be made by the students.
8. The report, project demonstration and technical presentations will be evaluated by the internal and external examiners.

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PROFESSIONAL ELECTIVE –

ELECTRONIC AUTOMATION

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U18EIE0001 **FLEXIBLE AND WEARABLE ELECTRONICS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify different types of wearable technology devices and issues involved.

CO2: Design and Verify energy harvesting techniques required for wearable technology devices

CO3: Apply various data mining techniques in Wearable algorithms and Interpret the results

CO4: Detect various types of diseases with wearable devices

CO5: Human Body Communication with high Data rate networks

CO6:

Pre-requisite: Nil

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

Course Assessment Methods:

Direct

- Internal Tests
- Assignment/Projects/Reports
- End semester exams

Course Content:

FUNDAMENTALS OF WEARABLE TECHNOLOGIES. 6 Hours

Wearables: Fundamentals, Advancements, and Roadmap for the future-Case Study: Google Glass - Wearable Haptics (sense of Touch)

WEARABLE CHEMICAL AND BIOCHEMICAL SENSORS -MEDICAL APPLICATIONS OF WEARABLE TECHNOLOGIES. 4 Hours

Introduction, System Design, Challenges in Chemical Biochemical Sensing, Application Areas, Applications of optical Heart Rate Monitoring

ENERGY EXPENDITURE AND ENERGY HARVESTING 9 Hours

Measurement of Energy Expenditure by Body-worn heat-Flow Sensors; Energy Harvesting at the Human Body, Energy Harvesting from Temperature Gradient at Human Body, from Foot Motion, from Light, Energy and Power Consumption Issues

Introduction to RF Energy Harvesting, Fundamentals, Practical considerations, Impedance mismatch, Losses, and Efficiency, Distribution of Harvested Power in a Realistic Environment, Charge pump Rectifier Technologies, Effect of Load and Source Variations,

FLEXIBLE ELECTRONICS AND TEXTILES FOR WEARABLE TECHNOLOGIES

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6 Hours

Knitted Electronic Textiles, From Fibers to Textile Sensors, The Interlaced Network, Textile Sensors for Physiological State Monitoring, Biomechanical Sensing; Non- Invasive Sweat Monitoring by Textile Sensors; Woven Electronic Textiles, Flexible Electronics from Foils to Textiles: Materials, Devices and Assembly; Plastic Electronics for Smart Textiles.

WEARABLE ALGORITHMS: 5 Hours

An overview of a Truly Multi-Disciplinary Problem, Why Do Wearable Sensors Need Algorithms, what are Wearable Algorithms? Wearable Algorithms: State -of -the-art and Emergency Techniques; Data Mining for Body Sensor Network, Mining Techniques for Body Sensor Network Data Repository; Physical Activity Modeling and Behavior Change, Modelling Physical Activity, Behavior-Change.

HUMAN BODY COMMUNICATION FOR A DATA RATE SENSOR NETWORK 7 Hours

High Data Rate Sensor Networks, IEEE802.15.6.TG6 Standard Models, Independent Studies-Trust Establishments in Wireless Body Area Networks, WBAN Device Authentication Techniques, Secret Key Establishment in WBAN

WEARABLE SENSORS FOR MONITORING OF PHYSICAL AND PHYSIOLOGICAL CHANGES AND FOR EARLY DETECTION OF DISEASES 4 Hours

Fundamentals of Wearable sensors for the Monitoring of Physical and Physiological Changes in Daily Life; Wearing Sensors Inside and Outside of the Human Body for Early Detection of Diseases.

WEARABLE AND NON-INVASIVE ASSISTIVE TECHNOLOGIES 4 Hours

Assistive Devices for Individuals with Severe Paralysis, Why Use of Tongue for Wearable Technology, Wireless Tracking of Tongue Motion, Wearable Tongue Drive System, Sensor Signal-Processing Algorithm, Dual Mode Tongue Driving Systems, Clinical Assessment

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

REFERENCES

1. Edward Sazonov, Michael R. Neuman (editors), Wearable Sensors: Fundamental Implementation and Applications, 2014, Academic Press/Elsevier, ISBN 978- 0124186620
2. Claire Rowland, Elizabeth Goodman, Martin Chalier, Ann Light, Alfred Lui, Designir Connected Products: UX for the Consumer Internet of Things, 2015, O'Reilly Media, Inc, ISB 978-1449372569
3. Honbo Zhou, Internet of Things in the Cloud – A Middleware Perspective, 2012, CRC Pres ISBN 978-1439892992

(Second and third books will help in designing the devices interfacing with IOT)

(Taken from Harvard Extension School)

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U18EIE0002 **LAB ON A CHIP**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Comprehend the Operating principles and physical mechanisms unique to microfluidics

CO2: Demonstrate an understanding of scaling of electrical, thermal, and fundamental dynamics in microsystems and the effects on system design

CO3: Propose design strategies for microfluidics systems based on fluid mechanical principles

CO4: Mathematically model microfluidic devices and systems.

Pre-requisite: Nil

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

Course Assessment Methods:	
Direct	**Indirect**
• Internal Tests • Assignment • End Semester Theory	• Course Exit Survey

Course Content:

Unit I **9 Hours**

Principles of miniaturisation, scaling laws - Theory of Microfluidics and nanofluidics - The diffusion of molecules and microscale mixing - Technological production of components: mixers and pumps

Unit II **9 Hours**

Fundamentals of electrical/electrochemical effects in microfluidics - DC fields in microsystems: electro-osmosis and electrophoresis - AC fields in microsystems: spectroscopy and dielectrophoresis

Unit III **9 Hours**

Soft lithography, novel methods and fabrication of Lab-on-a-Chip devices. - Detection methods – electrical, optical, thermal - Bio-analytical applications

Unit IV **9 Hours**

Magnetic particle biotechnology - Surfaces, forces, electrowetting: Digital Microfluidics - Diagnostic systems – medical systems - Separation, purification, concentration technologies

Unit V **9 Hours**

Simulation and design of mixing devices for chemical reactors

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

TEXT BOOKS:

1. https://www.southampton.ac.uk/courses/modules/elec6204.page#learning_and_teaching
2. Introduction to Microfluidics, Comprehensive online notes, Tabeling (2005)

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3. Marc J. Madou (2002). Fundamentals of Microfabrication, The Science of Miniaturization.
4. Gescheke et al, (2004). Microsystems Engineering of Lab-on-a-Chip Devices.
5. Nguyen and Wereley (2002|2006). Fundamentals and applications of microfluidics.

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U18EIE0003 **VLSI DESIGN**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Understand the concepts of MOS devices and characteristics of CMOS inverter.
CO2: Design combinational, sequential circuits and subsystem using various MOS logic circuits.
CO3: Describe the structure and operation of Programmable logic devices and testing.
CO4: Design simple combinational and sequential logic using VHDL programming.

Pre-requisite:

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	W										S	S	
CO2	S	S	M	M	S		M							
CO3	M	W				W						S	S	
CO4	S	S	M	M	M									

Course Assessment Methods:	
Direct	**Indirect**
• Internal Tests • Assignment • End semester exams	• Course Exit Survey

Course Content:

INTRODUCTION **9 Hours**

Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS technologies. Basic Electrical Properties of MOS and BiCMOS Circuits: Ids-Vds.
relationships, MOS transistor threshold Voltage, CMOS Inverter Circuits. Pass transistor, NMOS Inverter, Various pull ups, analysis and design, Bi-CMOS Inverters.

CMOS CIRCUIT AND LOGIC DESIGN **9 Hours**

CMOS logic structures: CMOS, pseudo NMOS, dynamic, clocked CMOS domino logic, CVSL, modified domino, pass transistor logics – example circuits- Stick Diagrams, Design Rules and Layout diagrams. Introduction to Back end tools : CADENCE and Micro wind.

SUBSYSTEM DESIGN **9 Hours**

Subsystem Design, Shifters, Adders, Multipliers, Parity generators, Comparators, Zero/One Detectors, Memory Elements.

PROGRAMMABLE DEVICES AND TESTING **9 Hours**

PLAs, FPGAs, CPLDs, Standard Cells, Programmable Array Logic, Testing of VLSI circuits – Testing stuck at faults – Path sensitization method - Boolean difference method.

VHDL **9 Hours**

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Introduction to VHDL – Types – Operators – Packages – Combinational and Sequential circuit – Sub-programs – Introduction to Test bench Simulation – Programs on counters, flipflops, FSM, Multiplexers / Demltiplexers. Simulation of combinational sequential circuits Modelsim.

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

REFERENCES

1. Principles of CMOS VLSI Design – Weste and Eshraghian, Pearson Education, 1999.
2. Modern VLSI Design – Wayne Wolf, Pearson Education, 3rd Edition, 1997
3. Eugene D.Fabricius, 'Introduction to VLSI Design', Tata McGraw Hill, 1990.
4. Douglas Perry, 'VHDL Programming by example', Tata McGraw Hill,3rd Edition, 2003.Zainalatsedin Navabi, 'VHDL Analysis and Modelling of Digital Systems',2nd Edition, Tata McGraw Hill, 1998.
5. Charles H.Roth, 'Fundamentals of Logic Design', Jaico Publishing House,1992

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U18EIE0004 **ROBOTICS AND FLEXIBLE AUTOMATION**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Describe the major concepts, components and applications of robotics (K2)

CO2: Analyze the transformation in different types of robots.(K4)

CO3: Apply the fundamental concepts of robotics path planning & work space.(K3)

CO4: Describe the technology and evaluation strategies (K2)

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L												
CO2	S		M										M	
CO3	S	M												
CO4	S												M	

Course Assessment Methods:
Direct
• Internal Tests • Assignment • End semester exams

Course Content:

CONCEPT OF ROBOTICS **9 Hours**

Introduction – types of robots – classification and specifications – various manipulators – elements of robots – different kinds of actuators – types of transmissions – purpose of sensors – encoders – tachometers – force & torque sensor – vision sensor – robot end effectors.

CO-ORDINATE TRANSFORMATION **9 Hours**

Direct knematic problem in robotics – geometry based direct kinematic analysis co-ordinate & vector transformation using matrices – direct & inverse kinematic analysis for Four axis SCARA robot – five and six articulated robots – homogeneous transformation.

WORK SPACE ANALYSIS AND TRACJECTORY INTERPOLATION **9 Hours**

Work envelope of a four axis SCARA robot and five axis Articulate robot – the pick and place operation – the necessity of interpolations – the tracjectory planning – structure of interpolators.

FLEXIBLE AUTOMATION TECHNOLOGY **9 Hours**

Introduction to Flexible Automation (FA) – FA tools – FA vs robotic technology – flexibility of robotization plan – group technology – grouping methods – data acquisitions – evaluation strategies – planning for robot installation.

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ROBOT APPLICATIONS **9 Hours**

Robot applications in manufacturing – material transfer and loading/unloading – processing operation like welding & painting – assembly operation – inspection automation – robot cell layouts – multiple robots & machine interference – social aspects of robotics – future applications.

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

REFERENCES:

1. Automation, Production System & Computer Integrated Manufacturing Groover Prentice Hall India
2. Principles of Automation & Automated Production Process Malov and Ivanov Mir Publication
3. Automation in Production Engineering Oates and Georgy Newness -
4. Stochastic Models of Manufacturing Systems Buzacott & shanty Kumar Prentice Hall India
5. Robotics K.S. Fu, R.C. Gonzalez, C.S.G. Lee McGraw Hill
6. Robotics J.J. Craig Addison-Wesely
7. Robot Engineering: An Integrated Approach R.D. Klafter, t.a. Chmielewski and M. Negin Prentice
8. Robotics & Control – R.K. Mittal & I.J. Nagrath – TMH Publications
9. Robotics for engineers - Yoram Korean- McGrew Hill Co.
10. Industrial Robotics Technology programming and Applications - M.P.Groover, M.Weiss, R.N.Nagel, N.G.Odrey.
11. Robotics Technology and flexible automation, S.R. Deb, TataMcGraw-Hill Education., 2009

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PROFESSIONAL ELECTIVE –

ADVANCED INSTRUMENTATION

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U18EIE0005 **WIRELESS SENSOR MEASUREMENT SYSTEMS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Describe the structure and configuration of various Buses used in transmission of DATA.(K2)

CO2: Analyze the suitable wireless data for various application.(K4)

CO3: Explain the fundamental concepts of various wireless IEEE protocol.(K2)

CO4: Analyze the specification details for the Smart data transmission.(K4)

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	W										S	S	
CO2	S		M											
CO3	M	W				W						S		
CO4		S		M										

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End semester exams

Course Content:

MEASUREMENT SYSTEM **7 Hours**

Configuration and structure of Measurement system, interface system, Measurement Accuracy and measurement system dynamics, Interface protection, computer for measurement system, computer architecture, universal serial bus, IEEE-1394 serial bus.

MEASUREMENT SYSTEM WITH SERIAL INTERFACE **9 Hours**

Measurement serial interface – introduction, RS-232 serial interface system, Programming of measurement system with RS-232 Serial interface, measurement system with RS-232 Serial interface and MODEM, Smart sensor interface-Smart sensors, PROFIBUS interface system, MODBUS interface system, Power line communication for measurement-general description of PLC, Communication protocol for PLC.

WIRELESS MEASUREMENT SYSTEM **7 Hours**

Wireless transmission of measurement Data, Radio Modem based measurement system, Bluetooth Radio Link, IEEE 802.15.4 (zigbee) Radio link, Other wireless transmission system.

MEASUREMENT SYSTEM WITH GSM and LTE **7 Hours**

Measurement System with GSM based data transmission, GSM based Distributed measurement

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system, UMTS, LTE, mobile station, positioning systems.

MEASUREMENT SYSTEM WITH IEEE488- INTERFACE **6 hours**

IEEE-488 parallel interface standard, interface message and their transfer, Enhancement in measurement with IEEE-488 interface, interface function state diagram.

CRATE AND MODULAR MEASUREMENT SYSTEM **9 Hours**

Introduction, CAMAC Dataway, VXI measurement system, PXI modular measurement system,IEEE-1284 interface with measurement system.

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

REFERENCES

1. Waldemar Nawrocki, “measurement systems and sensors” , 2nd Edition, 2001
2. National instruments ,“ Short Tutorial on VXI”
3. Tianbiao Zhang “Instrumentation, measurement, circuits and systems” , springer .

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U18EIE0006 **BIO SENSORS AND MEDICAL INSTRUMENTATION**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Impart basic knowledge about the biosensors and its types. (K3)

CO2: Illustrate the different methods of electrical and nonelectrical medical parameters diagnostic. (K2)

CO3: Explain the basic parameters of the equipment for using in electro diagnostic and electro therapy (K3)

CO4: Outline about the assisting and therapeutic medical equipment. (K2)

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						S	
CO2		M	S											M
CO3	S		M										S	
CO4			S											

Course Assessment Methods:
Direct
• Internal Tests • Assignment • End Semester Theory Exam

Course Content:

BIO SENSORS **(9 hours)**

Introduction to bio sensors - Classification of bio sensors based on transducers – types of bio sensors

ELECTRO – PHYSIOLOGICAL MEASUREMENTS **(9 hours)**

ECG Machine– Lead systems, Signal Conditioning, recording methods and typical waveforms. EEG Machine– Lead systems, Signal Conditioning, recording methods and typical waveforms. EMG Machine - Lead systems, Signal Conditioning, recording methods and typical waveforms. Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipment.Simulation of ECG and EMG signal.

NON-ELECTRICAL PARAMETER MEASUREMENTS **(9 hours)**

Measurement of blood pressure – Cardiac output – Cardiac rate – Heart sound – Respiratory rate – Plethysmography. Simulation of Blood pressure measurement.

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MEDICAL IMAGING AND PMS **(9 hours)**

X-ray machine - Radio graphic and fluoroscopic techniques – Computer tomography– MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Electrical safety.Processing of bio images using LABVIEW

LIFE ASSISTING AND THERAPEUTIC EQUIPMENTS **(9 hours)**

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators –Diathermy – Heart – Lung machine – Audio meters – Dialyzers - Lung machine – Audio meters – Lithotripsy - ICCU patient monitoring system

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

TEXT BOOKS

1. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 2007, 4th edition.
2. R.S.Khandpur, 'Handbook of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 2003, 3rd edition
3. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical Instrumentation and Measurements', II Edition, Pearson Education, 2011 / PHI.
4. https://nptel.ac.in/courses/118106019/36

References:

1. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman ltd, 2001.
2. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumenta- tion', John Wiley & Sons, 1975.3rd edition.

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U18EIE0007 **SENSOR AND DATA FUSION**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Describe the most important methods and algorithms for sensor fusion

CO2: Apply simple sensor data fusion methods and algorithms to any application

CO3: Implement the most common motion models in target tracking applications

CO4: Implement simple motion models for navigation applications.

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						S	
CO2		M	S											M
CO3	S		M										S	
CO4			S											

Course Assessment Methods:
Direct
• Internal Tests • Assignment • End Semester Theory

Course Content:

INTRODUCTION **9 hours**

Perception and Sensing - Background and State of the Art in Perceptual Fusion - Fusion and Dynamic World Modeling - A General Framework for Dynamic World Modeling - Principles for Integrating Perceptual data

BAYESIAN STATISTICS AND RECURSIVE ESTIMATION THEORY **3 hours**

State Representation: A Vector of Properties - Prediction: Discrete State Transition Equations - Matching Observation to Prediction: The Mahalanobis Distance.

KALMAN FILTER **9 hours**

Updating: The Kalman Filter Update –equations- Eliminating Uncertain Primitives and Adding New Primitives- Fusion of Symbolic properties - Philosophical Foundations- Principles for Symbolic Fusion.

MODELING **9 hours**

A Symbolic Form of the Predict, Match and Update Cycle - Example Systems Constructed in the Framework. - Dynamic World Modeling Using Ultrasound-2D Edge Segment Following - Vertical Line Stereo System - World Modeling Using Ultrasound and Vertical Line Stereo - An Integrated Active Vision System.

SENSOR FUSION APPLICATIONS **9 hours**

Vehicle motion estimation using night vision – Fighter aircraft navigation – Autonomous helicopter landing – Helicoptor pose estimation using map – Indoor positioning using a map

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– Indoor human motion estimation

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

TEXT BOOKS:

1. https://www.edx.org/course/sensor-fusion-and-non-linear-filtering-for-automotive-systems
2. Dr. Ciza Thomas, "Sensor Fusion and Its Applications" Sciyo Publications, Croatia, 2010
3. "Multi-Sensor Data Fusion: An Introduction" by H B Mitchell, Springer, 1st ed. 2007 edition
4. "Tracking and Sensor Data Fusion (Mathematical Engineering)" by Wolfgang Koch, Springer Nature, 2014
5. "Sensor Data Fusion Systems" by Dakhlallah Tarek, LAP Lambert Academic Publishing, 2012
6. "Sensor and Data Fusion: A Tool for Information Assessment and Decision Making ,Spie Press Monograph, " by Lawrence A Klein, SPIE Press; 2 edition 2012

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U18EIE0008 MACHINE VISION

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Select suitable Machine vision algorithms using modern computer programming environment as an interactive problem solving tool and Comprehend the complete process involved in solving a machine vision problem.

CO2: Use the suitable Low level Image Transformation techniques for the given application.

CO3: Apply the proper tool for segmentation, edge and region detection for any given problem

CO4: Perform the textural analyses for any application.

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	S	S				M	S		W	S	
CO2	S	S	S	S	S					S			S	
CO3	S	M	W	W	S					W			W	
CO4	S	M	W	W	S			M		M			W	

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End semester exams

Course Content:

Machine Vision and Binary Algorithms (9 hrs)

Introduction - Relationships to Other Fields - Image Geometry - Perspective Projection - Coordinate Systems - Binary Image Processing - Binary Algorithms - Region Boundary - Distance Measures and Transforms -Thinning - Expanding and Shrinking - Morphological Operators - Optical Character Recognition

Region and Edge Detection (8 hrs)

Regions and Edges - Region Segmentation - Automatic Thresholding - Region Representation - Array Representation - Edge and Line Detection - Hierarchical Representations - Symbolic Representations - Data Structures for Segmentation - Split and Merge - Region Merging - Removing Weak Edges - Region Splitting - Split and Merge - Region Growing

Image Filtering and Curve fitting (10 hrs)

Image Filtering - Histogram Modification - Linear Filters - Gaussian Smoothing -

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Rotational Symmetry - Fourier Transform Property - Gaussian Separability - Designing Gaussian Filters - Geometry of Curves - Curve Fitting - Split and Merge - Hop-Along Algorithm - Circular Arcs - Conic Sections-Curve Approximation- Robust Regression - Hough Transform - Fourier Descriptors

Texture Analyses **(8 hrs)**

Textural analyses - Statistical Methods - Structural Analysis - Model-Based Methods - Shape from Texture - Optics - Lens Equation - Image Resolution - Depth of Field - View Volume - Shading -Illumination and Reflectance -Surface Orientation - The Reflectance Map - Diffuse Reflectance - SEM - Shape from Shading - Photometric Stereo- Color Physics - Color Processing - Color Constancy - Stereo Imaging

Dynamic Vision **(10 hrs)**

Stereo Matching - Edge Matching - Active Vision - Rigid Body Transformations - Orientation - Depth from Binocular Stereo - Camera Calibration - Curves and Surfaces - Geometry of Curves and Surfaces - Planes - Differential Geometry - Curve Representations -- Dynamic Vision Segmentation Using a Moving Camera - Classification - Matching - Feature Indexing - Verification - Template Matching - Analogical Methods

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

REFERENCES

1. Davis, E. R. 1997. Machine Vision. 2nd Ed. San Diego, California: Academic Press.
2. Jain, R. J., R. Kasturi and B. G. Schunck. 1995. Machine Vision. New York: McGraw-Hil
3. Haralick, R. M. and L. G. Shapiro. 1992. Computer and Robot Vision. Vol. 1 & 2. Readin Massachusetts: Addison-Wesley Publishing Company, Inc.
4. Faugeras, O. 1999. Three-Dimensional Computer Vision: A Geometric Viewpoint. Cambr Massachusetts: The MIT Press.

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PROFESSIONAL ELECTIVE –

PROCESS AUTOMATION

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U18EIE0009 **FAULT DETECTION AND DIAGNOSIS**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify the different type of faults occurred in a system.

CO2: Apply mathematical techniques to detect faults.

CO3: Apply structured and directional techniques for FDI design.

CO4: Describe the Artificial Neural network and Fuzzy logic schemes in FDD

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	W										S		M
CO2	S	S	M	M										
CO3	M	W				W						S		M
CO4	S	M	W	W						M				

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End semester exams

Course Content:

INTRODUCTION TO FAULT DETECTION AND DIAGNOSIS **9 Hours**

Scope of FDD: Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances -Different issues involved in FDD-Typical applications.

DESIGN OF RESIDUAL GENERATOR FOR LINEAR I/O MODELS **9 Hours**

Analytical Redundancy Concepts: Residual Generation: Linear I/O Models (Continuous and Discrete Time) ; State Estimation : State Observers. Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation , Residual Generation with State Estimators.

MULTIPLE FAULT ISOLATION **9 Hours**

Introduction - Residual structure of single fault Isolation: Structural and Canonical structures - Residual structure of Multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.

DESIGN OF DIRECTIONAL STRUCTURED RESIDUALS **9 Hours**

Introduction– Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column.

ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC SCHEMES IN FDD **9 Hours**

Advanced level issues and design involved in FDD: Introduction of Residual generation

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of parametric fault –Parameter Estimations of Dynamic Models- Robustness Issues –Statistical Hypothesis Testing of Residual generators – Artificial Neural network and Fuzzy logic schemes in FDD – Case study for Automotive systems and Industrial Applications.

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

REFERENCES

1. Rolf Isermann, Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance, Springer Verlag, 2006.
2. Sachin. C. Patwardhan, Fault Detection and Diagnosis in Industrial Process –Lecture Notes, IIT Bombay, February 2005.
3. Janos J. Gertler, Fault Detection and Diagnosis in Engineering systems, Macel Dekker, 2nd Edition, 1998.
4. Rami S. Mangoubi, Robust Estimation and Failure detection. Springer- Verlag - London 1998.
5. Steven X. Ding, Model based Fault Diagnosis Techniques: Schemes, Algorithms, and Tools, Springer Publication, 2012
6. Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas amseddine, FaultTolerant Control Systems: Design and Practical Applications, Springer Publication, 2009.
7. Mogens Blanke, Michel Kinnaert, Jan Lunze, Marcel Staroswiecki., Diagnosis and Fault -Tolerant Control, Springer, 2016.

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U18EIE0010 ADVANCED INTELLIGENT CONTROLLERS

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):
After Successful completion of this course, the students will be able to :
CO1: Apply Various Soft Computing Frame Works. K2
CO2: Design Of Various Neural Networks. K3
CO3: Use of Fuzzy Logic. K3
CO4: Apply Genetic Programming. K3

Pre-requisite: - Nil-

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	S	S	S				W					
CO2		M	S	S	S									M
CO3		M	S	S	S									
CO4		M	S	S	S									

Course Assessment Methods:
Direct
• Internal Tests • Assignment • End semester exams

Course Content:

INTRODUCTION TO SOFT COMPUTING 7 Hours

Concept of computing systems-Soft computing versus Hard-computing Characteristics of Soft computing-Some applications of Soft computing techniques.

NEURAL NETWORKS & ARTIFICIAL NEURAL NETWORKS 10 Hours

Evolution of neural network-Linear Separability – Hebb Network – Supervised Learning Network: Perceptron Networks – Adaptive Linear Neuron, Multiple Adaptive Linear Neuron, BPN, RBF, TDNN- Biological neurons and its working - Simulation of biolgical neurons to problem solving.- Different ANNs architectures-Training techniques for ANNs- Applications of ANNs to solve some real life problems.

FUZZY LOGIC 10 Hours

Introduction to Fuzzy logic-Fuzzy sets and membership functions - Operations on Fuzzy sets- Fuzzy relations, rules, propositions, implications and inferences- Defuzzification techniques-Fuzzy logic controller design-Some applications of Fuzzy logic.

GENETIC ALGORITHM 10 Hours

Concept of "Genetics" and "Evolution" and its application to proablistic search techniques - Basic GA framework and different GA architectures -GA operators: Encoding, Crossover, Selection, Mutation-Solving single-objective optimization problems using Gas-Concept of multi-objective

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optimization problems (MOOPs) and issues of solving them-Multi-Objective Evolutionary Algorithm (MOEA)-Non-Pareto approaches to solve MOOPs.

HYBRID SOFT COMPUTING TECHNIQUES & APPLICATIONS **8 Hours**

Neuro-Fuzzy Hybrid Systems – Genetic Neuro Hybrid Systems – Genetic Fuzzy Hybrid And Fuzzy Genetic Hybrid Systems – Simplified Fuzzy ARTMAP – Applications: A Fusion Approach Of Multispectral Images With SAR, Optimization Of Traveling Salesman Problem Using Genetic Algorithm Approach, Soft Computing Based Hybrid Fuzzy Controllers.

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

Text Books:

1. J.S.R.Jang, C.T. Sun And E.Mizutani, "Neuro-Fuzzy And Soft Computing", PHI / Pearson Education 2004.
2. S.N.Sivanandam And S.N.Deepa, "Principles Of Soft Computing", Wiley India Pvt Ltd, 2011.

REFERENCES:

1. David E. Goldberg, "Genetic Algorithm In Search Optimization And Machine Learning" Pearson Education India, 2013.
2. S.Rajasekaran And G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic And Genetic Algorithm: Synthesis & Applications", Prentice-Hall Of India Pvt. Ltd., 2006.
3. Simon Haykin, "Neural Networks Comprehensive Foundation" Second Edition, Pearson Education, 2005.

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U17EIE0011	INDUSTRY 4.0	

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to:

CO1: Comprehend the drivers and enablers of Industry 4.0

CO2: Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.

CO3: Outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world

CO4: Analyze the power of Cloud Computing in a networked economy

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						S	
CO2		S					M	S						M
CO3	S		M										S	
CO4			S											

Course Assessment Methods:

Direct
• Internal Tests • Assignment End Semester Theory

Course Content:

Course Content:

UNIT I **9 Hrs**

The Various Industrial revolutions –Introduction to Industry 4.0: Sensing & actuation, Industrial Connectivity, Industry Networking, Cyber Physical Systems and Next Generation Sensors.

UNIT II **9 Hrs**

Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis, Cyber security in Industry 4.0, Basics of Industrial IoT: Industrial Processes, Industrial Sensing & Actuation, Industrial Internet Systems.

UNIT III **9 Hrs**

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: Industrial IoT-Layers: IIoT Sensing, IIoT Processing, IIoT Communication-IIoT Networking- IIoT Analytics - Introduction, Machine Learning and Data Science R and Julia Programming, Data Management with Hadoop.

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UNIT IV **9 Hrs**

Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT, Data Center Networks in Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT. Introduction to Edge computing

UNIT V **9 Hrs**

Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management.

Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies :

Case study - I : Milk Processing and Packaging Industries

Case study - II: Manufacturing Industries - Part I

Case study - III : Manufacturing Industries - Part II

Case study - IV : Student Projects - Part I

(Edge Computing)

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

REFERENCES

1. "Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress)
2. "Industrial Internet of Things: Cybermanufacturing Systems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)
3. https://courses.edx.org/courses/course-v1:HKPolyUx+I4.0x+2T2018/course/
4. Klaus Schwab, "The Fourth Industrial Revolution" World Economic Forum, 2016
5. Fran Yáñez, "The Goal is Industry 4.0: Technologies and Trends of the Fourth Industrial Revolution", independently published**,** 2017
6. Klaus Schwab, "The Fourth Industrial Revolution: what it means, how to respond" World Economic Forum, 2016
7. Mr Kiran Kumar Pabbathi, **"**Quick Start Guide to Industry 4.0: One-stop reference guide for Industry 4.0", CreateSpace Independent Publishing Platform, 2018

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U18EIE0012 **SYSTEM IDENTIFICATION, MODELLING AND SIMULATION**

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Choose the correct model structure

CO2: Design inputs (probe signals) for identification

CO3: Estimate the non-parametric and parametric models

CO4: Perform the data pre-processing for identification

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						S	
CO2		M			S									M
CO3	S	S			M								S	
CO4		M												

Course Assessment Methods:
Direct
• Internal Tests • Assignment • End Semester Theory

Course Content:

MODELS OF DETERMINISTIC LTI SYSTEMS **9 Hours**

Discrete-time convolution models, response-based models, difference equation descriptions, transfer function and state-space models, discretization. Stochastic processes: Review (auto- and cross-correlation functions, white- noise process and ARMA models).

BASICS OF ESTIMATION THEORY **9 Hours**

Estimators, bias and variance, convergence, consistency, asymptotic distribution of parameter estimates. Generic estimation methods: Ordinary least squares, Variants of LS methods, Maximum Likelihood Estimation.

INPUT-OUTPUT MODELS FOR IDENTIFICATION: **9 Hours**

non-parametric (step, impulse and frequency response) and parametric models (ARX, ARMAX, OE, B-J).Prediction: one-step ahead prediction, k-step ahead predictors, simulation

IDENTIFICATION OF NONPARAMETRIC AND PARAMETRIC MODELS:9Hours

Estimation of impulse response and frequency response functions; prediction-error minimization (PEM) methods, correlation methods, instrumental variable (IV) methods. Statistical and Practical Aspects: time-delay estimation, diagnostics for model quality checks, residual analysis, model validation, and handling drifts, outliers and missing data; input design.

IDENTIFICATION OF STATE-SPACE MODELS: **9 Hours**

Kalman filter, subspace identification methods, Grey-box modeling. Advanced topics:

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Recursive and closed-loop identification..

Theory Hours: 45	Practical hours : 0	Total Hours: 45

TEXT BOOKS:

1. System Identification: Theory for the User , 2nd Edition, Prentice Hall by Lennart Ljung, 1999.
2. System Identification: An Introduction , 2011by Karel J. Keesman, Springer
3. Mastering System Identification in 100 Exercises –2012 by Johan Schoukens , Wiley-IEEE Press
4. Principles of System Identification: Theory and Practice Hardcover –2014
by Arun K. Tangirala, CRC Press
5. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition –2017by Trevor Hastie, Springer.

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PROFESSIONAL ELECTIVE - GENERAL

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U18EIE0013 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: Able to understand the practical aspects of data science and its evolution and apply the concepts and methods to solve problems in real-world contexts.

CO2: Able to understand and code basic programs in Python language that pertains to the use of machine learning and related algorithms, Gain knowledge about basic concepts of Machine Learning.

CO3: Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications integrating with the standard ML Libraries.

CO4: Able to understand the deep learning techniques and develop a basic DNN using Tensor flow.

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1 (K2)	S	M	S	S			M			M		M		M
CO2 (K3)	M	M	S	M		M						M		M
CO3 (K3)	M	S	W	W			S			S				S
CO4 (K3)	M	M	S	S				S			S	M		S

S-Strong M-Medium L-Low

Course Assessment methods:

Direct
Continuous assessment tests Assignments End Semester Exam

Course content

Introduction to Artificial Intelligence and Machine learning Basics 9 Hrs

Terminologies and differences between them – Artificial Intelligence, Machine Learning, Deep Learning. Data Analytics, Data Science & AI – The Connection, History of AI (evolution of AI) Real world use cases of AI.

Types of Machine Learning – Supervised, Unsupervised and Reinforcement, Basic ML process, Cost functions, Bias and Variance, Regularization

Python for ML and ML algorithms 12 Hrs

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Introduction to python, Variables, Data types, List and Tuple operations, Import, Conditional statements, Functions.
Linear Regression, Logistic Regression, Support Vector Machines, K-Nearest Neighbours, Decision Tree, Random Forest

ML Libraries and Case studies **19 Hrs**

Numpy (key operations), Pandas (Series, DataFrame, key operations), Matplotlib (basic plotting), Seaborn (key plots), Scikit-learn(key algorithms and operations). Case study - Regression problem, Classification problem

Deep Learning **5 Hrs**

Introduction, Forward propagation, Back propagation, Optimizers, Types - Dense Neural Networks (DNN), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Introduction to Tensor flow, Building a basic DNN using Tensorflow.
Applications on Machine learning

TEXT BOOKS:

1 S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009.

2 I. Bratko, ―Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

3. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

4. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2009.

K.K.

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U18EIE0014 **BIG DATA ANALYTICS**

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: Work with big data tools and its analysis techniques.

CO2: Analyse data by utilizing clustering and classification algorithms.

CO3: Learn and apply different mining algorithms and recommendation systems for large volumes of data.

CO4: Perform analytics on data streams

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1 (K2)	S	M	S	S			M			M		M		S
CO2 (K3)	M	S	S	M		M						M		S
CO3 (K3)	M	S	W	W			S			S				S
CO4 (K3)	M	S	S	S				S			S	M		S

S-Strong **M-Medium** **L-Low**

Course Assessment methods:

Direct
Continuous assessment tests Assignments End Semester Exam

Course content

INTRODUCTION TO BIG DATA **9 Hrs**

Evolution of Big data – Best Practices for Big data Analytics – Big data characteristics – Validating – The Promotion of the Value of Big Data – Big Data Use Cases- Characteristics of Big Data Applications – Perception and Quantification of Value -Understanding Big Data Storage – A General Overview of High-Performance Architecture – HDFS – MapReduce and YARN – Map Reduce Programming Model Provisioning.

CLUSTERING AND CLASSIFICATION **9 Hrs**

Advanced Analytical Theory and Methods: Overview of Clustering – K-means – Use Cases – Overview of the Method – Determining the Number of Clusters – Diagnostics – Reasons to Choose and Cautions .- Classification: Decision Trees – Overview of a Decision Tree – The General Algorithm – Decision Tree Algorithms – Evaluating a Decision Tree – Decision Trees in R – Naïve Bayes – Bayes‘ Theorem – Naïve Bayes Classifier.

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ASSOCIATION AND RECOMMENDATION SYSTEM **9 Hrs**

Advanced Analytical Theory and Methods: Association Rules – Overview – Apriori Algorithm – Evaluation of Candidate Rules – Applications of Association Rules – Finding Association& finding similarity – Recommendation System: Collaborative Recommendation- Content Based Recommendation – Knowledge Based Recommendation- Hybrid Recommendation Approaches.

STREAM MEMORY **9 Hrs**

Introduction to Streams Concepts – Stream Data Model and Architecture – Stream Computing, Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating moments – Counting oneness in a Window – Decaying Window – Real time Analytics Platform(RTAP) applications – Case Studies – Real Time Sentiment Analysis, Stock Market Predictions. Using Graph Analytics for Big Data: Graph Analytics

NOSQL DATA MANAGEMENT FOR BIG DATA AND VISUALIZATION 9 Hrs

NoSQL Databases : Schema-less Models‖: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores – Tabular Stores – Object Data Stores – Graph Databases Hive – Sharding –- Hbase – Analyzing big data with twitter – Big data for E-Commerce Big data for blogs – Review of Basic Data Analytic Methods using R.

Theory: 45 Hrs. **Total hrs. 45 hrs.**

TEXT BOOKS:

1. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
2. David Loshin, “Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph”, Morgan Kaufmann/El sevier Publishers, 2013.

REFERENCES:

1. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
2. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.
3. Dietmar Jannach and Markus Zanker, “Recommender Systems: An Introduction”, Cambridge University Press, 2010.
4. Kim H. Pries and Robert Dunnigan, “Big Data Analytics: A Practical Guide for Managers ” CRC Press, 2015.
5. Jimmy Lin and Chris Dyer, “Data-Intensive Text Processing with MapReduce”, Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010.

U18EIE0015 **CLOUD 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: Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
CO2: Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
CO3: Explain the core issues of cloud computing such as resource management and security.
CO4: Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1 (K2)	S	M	S	S			M			M		M		S
CO2 (K3)	M	M	S	S		M						M		S
CO3 (K3)	M	S	W	W			S			S				S
CO4 (K3)	M	M	S	S				S			S	M		S

S-Strong **M-Medium** **L-Low**

Course Assessment methods:

Direct
Continuous assessment tests Assignments End Semester Exam

Course content

INTRODUCTION **9 Hrs**

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning.

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CLOUD ENABLING TECHNOLOGIES **9 Hrs**

Service Oriented Architecture – REST and Systems of Systems – Web Services – PublishSubscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU –Memory – I/O Devices –Virtualization Support and Disaster Recovery.

CLOUD ARCHITECTURE, SERVICES AND STORAGE **9 Hrs**

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds – laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.

RESOURCE MANAGEMENT AND SECURITY IN CLOUD **9 Hrs**

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.

CLOUD TECHNOLOGIES AND ADVANCEMENTS **9 Hrs**

Hadoop – MapReduce – Virtual Box — Google App Engine – Programming Environment for Google App Engine — Open Stack –Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation.

Theory: 45 Hrs. **Total hrs. 45 hrs.**

TEXT BOOKS:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, ―Cloud Computing: Implementation, Management and Security‖, CRC Press, 2017.

REFERENCES:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, ―Mastering Cloud Computing‖, Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach‖, Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)‖, O'Reilly, 2009.

K.K.

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U18EIE0016	VIRTUAL REALITY AND AUGMENTED REALITY	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 principles of Virtual environments
CO2: Analyse the 3D user interface hardware

CO3: Learn and apply different software technologies in Virtual environments
CO4: Design and develop virtual reality applications

COs	Programme Outcomes (POs)												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1 (K2)	S	M	S	S			M			M		M		S
CO2 (K3)	M	S	S	M		M						M		S
CO3 (K3)	M	S	W	W			S			S				S
CO4 (K3)	M	S	S	S				S			S	M		S

Course Content

VIRTUAL REALITY AND VIRTUAL ENVIRONMENTS: 4 hrs

The historical development of VR: Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality.

HARDWARE TECHNOLOGIES FOR 3D USER INTERFACES: 6hrs

Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces.

3D USER INTERFACE INPUT HARDWARE: 5 hrs

Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces.

SOFTWARE TECHNOLOGIES: 10hrs

Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and

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Cameras, Scripts, Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits, Available software in the market

3D INTERACTION TECHNIQUES: 8hrs

3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Deign Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding, User Centered Wayfinding Support, Environment Centered Wayfinding Support, Evaluating Wayfinding Aids, Design Guidelines - System Control, Classification, Graphical Menus, Voice Commands, Gestrual Commands, Tools, Mutimodal System Control Techniques, Design Guidelines, Case Study: Mixing System Control Methods, Symbolic Input Tasks, symbolic Input Techniques, Design Guidelines, Beyond Text and Number entry

DESIGNING AND DEVELOPING 3D USER INTERFACES: 2hrs

Strategies for Designing and Developing Guidelines and Evaluation.

Real WORLD Z XZ3D USER INTERFACES: 6hrs

3D User Interfaces for the Real World, AR Interfaces as 3D Data Browsers, 3D Augmented Reality Interfaces, Augmented Surfaces and Tangible Interfaces, Agents in AR, Transitional AR-VR Interfaces - The future of 3D User Interfaces, Questions of 3D UI Technology, 3D Interaction Techniques, 3D UI Design and Development, 3D UI Evaluation and Other Issues.

VIRTUAL REALITY APPLICATIONS: 4 hrs

Engineering, Architecture, Education, Medicine, Entertainment, Science, Training.

Theory : 45 Hrs Total Hrs: 45

REFERENCES:

1. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009.
2. Gerard Jounghyun Kim, “Designing Virtual Systems: The Structured Approach”, 2005.
3. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, “3D User Interfaces, Theory and Practice”, Addison Wesley, USA, 2005.
4. Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: Meging Real and Virtual Worlds”, 2005.
5. Burdea, Grigore C and Philippe Coiffet, “Virtual Reality Technology”, Wiley Interscience, India, 2003.
6. John Vince, “Virtual Reality Systems”, Addison Wesley, 1995.
7. Howard Rheingold, “Virtual Reality: The Revolutionary Technology and how it Promises to Transform Society”, Simon and Schuster, 1991.
8. William R Sherman and Alan B Craig, “Understanding Virtual Reality: Interface, Application and Design (The Morgan Kaufmann Series in Computer Graphics)”. Morgan Kaufmann Publishers, San Francisco, CA, 2002.

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U18EIE0017 INDUSTRIAL ELECTRONIC DRIVES

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: Choose the power devices based on the application. (K3)
CO2: Evaluate the performance parameters of AC-DC converters with R, RL and RLE Load. (K3)
CO3: Describe the functioning of various DC-DC converters and inverters. (K3)
CO4: Identify the drives for various control applications. (K3)

Pre-requisite courses:

1. U18EII1201: Basic Electronics
2. U18EII2201: Electric Circuits
3. U18EII3201: Analog Electronics

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

COs	Programme Outcomes (POs) / Programme Specific Outcomes (PSOs)													
	PO1 (K3)	PO2 (K4)	PO3 (K5)	PO4 (K5)	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1 (K4)	PSO2 (K4)
CO1 (K3)	S	M	W										M	
CO2 (K3)	S	M	W	W									M	
CO3 (K3)	S	M	W	W									M	
CO4 (K3)	S	M	W	W									M	

Course Contents

POWER CONVERSION & POWER SEMICONDUCTOR SWITCHES 7 Hrs

Need for power conversion - Power electronic converters - classifications and scope; Construction, Operating Principle, Static and Dynamics Characteristics of Power Diode - Power BJT -SCR - TRIAC- MOSFET – IGBT; Ratings & Protection of Switches.

CONVERTERS 9 Hrs

Single Phase and Three Phase Half & Fully Controlled Rectifier with R, RL, RLE Load - Effect of Source Inductance - Continuous and Discontinuous Mode of Operation - Performance Analysis – Dual Converter – Simulation Analysis of Converters using MATLAB / MULTISIM.

CHOPPERS 8 Hrs

Step up and Step down Chopper – Chopper Classification - Quadrant of Operation – Switching Mode Regulators - Buck, Boost, Buck-Boost, and Cuk Regulators - Simulation Analysis of Choppers using MATLAB / MULTISIM.

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INVERTERS **9 Hrs**

Single Phase and Three Phase (both 120^{o} and 180^{o} Modes of Operation) Inverters - PWM techniques: Sinusoidal PWM, Modified Sinusoidal PWM and Multiple PWM – Voltage Source Inverters - Current Source Inverters - Multilevel Inverters - Simulation Analysis of Inverters using MATLAB / MULTISIM.

INDUSTRIAL DRIVES & APPLICATIONS **12 Hrs**

Determination of Speed and Torque Requirements for Specific Motion Profiles, Introduction to DC Drives & AC Drives - Electrical Braking -Regenerative Breaking- Open loop and Closed Loop Control of Drives (Block Diagram Approach only) - Stepper Motor Drives - Position Control - Servo Drives.

Applications: Switched Mode Power Supply - Uninterrupted Power Supply – FACTS – HVDC Transmission.

Theory : 45 Hrs **Total Hrs: 45**

REFERENCES

1. Muhammad H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Prentice Hall of India / Pearson Education, 4th Edition, 2017, ISBN-13: 978-9332584587.
2. Singh M.D. Khanchandani, K.B., "Power Electronics", 3rd Edition, McGraw-Hill, 2017, ISBN 13: 9780070583894.
3. Bimbhra P. S. 'Power Electronics', Khanna Publishers, 2006 ISBN-13: 978-8174092151.
4. Ned Mohan, Tore. M. Undelan, William P. Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and Sons, Third Edition, 2007, ISBN-13:978126510900.
5. Bimal K. Bose, 'Modern Power Electronics and AC Drives', Pearson Education, 1st Edition, 2015, ISBN-13: 978-9332557550.
6. Moorthi V. R., 'Power Electronics - Devices, Circuits and Industrial Applications', Oxford
   University Press, 2005, ISBN: 9780195670929.
7. Dubey G. K., 'Power Semiconductor Controlled Drives,' Prentice Hall International, New Jersey, 1989, ISBN-13: 978-0136868903.

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U18EIE0018	BUILDING AUTOMATION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Understanding of basic blocks and systems for building automation.

CO2: Designing different systems for building automation and integrate those systems.

CO3: Understand the concept of automation in access control system for safety.

CO4: Know about Fire and alarm system

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						S	
CO2		M	S											M
CO3	S		M										S	
CO4			S											

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End Semester Theory

Course Content:

Course content

INTRODUCTION **8 Hrs**

Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

HVAC SYSTEM **8 Hrs**

Different components of HVAC system like heating, cooling system, chillers, AHUs, compressors and filter units and their types. Design issues in consideration with respect to efficiency and economics, concept of district cooling and heating.

ACCESS CONTROL &SECURITY SYSTEM **8 Hrs**

Concept of automation in access control system for safety, Physical security system with components, RFID enabled access control with components, Computer system access control – DAC, MAC, RBAC

FIRE &ALARM SYSTEM **7 Hrs**

Different fire sensors, smoke detectors and their types, CO and CO2 sensors, Fire control panels, design considerations for the FA system concept of IP enabled fire&alarm system, design aspects and components of PA system.

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CCTV SYSTEM &ENERGY MANAGEMENT SYSTEM **7 Hrs**

Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system, concept of energy management system, occupancy sensors, fans & lighting controller.

EPBX SYSTEM & BMS SUBSYSTEM INTEGRATION **7 Hrs**

Design consideration of EPBX system and its components, integration of all the above systems to design BMS.

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

REFERENCE BOOK

1. Building Control Systems, Application Guide (CIBSE Guide), CIBSE, 2000.
2. Smart Buildings by Jim Sinopoli, Butterworth-Heinemann imprint of Elsevier, 2 nd ed., 2010
3. Design of Special Hazards and Fire Alarm Systems, Robert Gagnon, 2007

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U18EIE0019	OPTICAL INSTRUMENTATION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Understand the working of optical fiber as a sensor

CO2: Study and identify applications of LASER in instrumentation & measurement

CO3: Identify the optic sources and detectors.

CO4: Apply and usage of optical fiber to measure various physical parameters

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						S	
CO2		M	S											M
CO3	S		M										S	
CO4			S											

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End Semester Theory

Course Content:

OPTICAL FIBER WAVEGUIDE **8 Hrs**

Ray theory of transmission, total internal reflection, and electromagnetic mode theory of optical propagation, cylindrical fiber, classification of fibers, manufacturing of optical fiber.

TRANSMISSION CHARACTERISTICS OF OPTICAL FIBER **8 Hrs**

Attenuation, material absorption losses, scattering losses, nonlinear and linear scattering, fiber bend loss, dispersion, intermodal dispersion, dispersion modified single mode fiber, dispersion flattened fibers, polarization, nonlinear phenomena. Serial real time communication systems (SERCOS)

OPTICAL SOURCES AND DETECTORS **8 Hrs**

Optical emission from semiconductor, semiconductor LASER, non semiconductor LASER, LED as an optical source, optical detector principles, absorption, quantum efficiency, responsively, photo diodes, modulation.

OPTICAL FIBER SENSORS **7 Hrs**

Introduction to fiber optics sensors, sensors based on intensity modulation, application of optical fiber for displacement, strain, stress and pressure measurement. Active multimode FO sensors,

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micro-bend optical fiber sensors, current sensors, phase modulated, polarization modulated optical fiber sensors, fiber optic gyroscope.

LASER APPLICATIONS **7 Hrs**

Introduction, application of LASER in biomedical instrumentation, LASER interferometry, performance parameters, LASER telemeters, measurement of distance, LIDAR, holography: basic principle of holography, measurement of strain, stress, bending moments and vibrations using hologram.

OPTICAL AMPLIFICATION AND INTEGRATED OPTICS **7 Hrs**

Optical amplifiers, integrated optics integrated optical devices: beam splitters, directional couplers, modulators, switches, optoelectronics integration and differentiation, analog arithmetic operations, digital optics

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

REFERENCE BOOK

1. Jose Miguel Lopez, ―Optical fiber sensing technology‖, John Wiley & Sons, 2002
2. AjoyGhatak, ―Optics‖, Tata Mc- Graw Hill Publishing, 5thed., 2012
3. Joseph T Verdeyen, ―LASER Electronics‖, Prentice Hall of India, 3rded., 2003
4. John M. Senior, ―Optical fiber Communications Principles and Practice‖, PHI publication, 2nd ed., 2008

K.K.

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U18EIE0020	STATISTICAL PROCESS CONTROL		L	T	P	J	C
			3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify the different uses of control charts

CO2: Choose appropriately and correctly apply Control charts to most of the processes

CO3: Accurately interpret these charts to quickly detect any changes in process output

CO4 Stabilize a process to produce consistent products

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S						W						S	
CO2		M	S											M
CO3	S		M										S	
CO4			S											

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End Semester Theory

Course Content:

Course Content:

UNIT I: INTRODUCTION TO SPC: 4 Hrs

Concept of quality, Quality control and Quality improvement; Role of SPC in this context, Concept of variation due to common and assignable causes; meaning of control, expected benefits of SPC.

UNIT II: CONTROL CHARTS: 9 Hrs

b. Introduction to Shewhart Control charts, Statistical basis for control charts, Control chart for variables and attributes: X MR, Xbar R, Xbar s, np, p, c, u charts.
c. Sloping control chart, modified control charts, CUSUM chart, EWMA chart, Precontrol chart, Run Chart. c. Usage of statistical software (like Minitab, SPSS, Systat, Statistica, JMP etc) for construction of control chart with live data.

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UNIT III: PROCESS CAPABILITY ANALYSIS: 8 Hrs

a. Process capability Analysis, process capability and machine capability indices (Cp, Pp, Cpk,PpkCpk)
b. Estimation of process capability indices for live data by statistical software (like Minitab, SPSS, Systat, Statistica, JMP etc)

UNIT IV: MEASUREMENT SYSTEM ANALYSIS: 12 Hrs

a. Measurement system analysis Definition of bias, linearity, stability, repeatability & reproducibility. Selection of appropriate gauge for measurement purpose.
b. Estimation of measurement error (Repeatability & Reproducibility) for variable data by ANOVA & Control Chart method.
c. Estimation of Kappa for attribute data.
d. Usage of statistical software (like Minitab, SPSS, Systat, Statistica, JMP etc) for estimation of Gauge R & R and Kappa values from live data.

UNIT V: ACCEPTANCE SAMPLING: 12 Hrs

a. Purpose of sampling inspection, Critique of acceptance sampling, Relevance of sampling inspection in todays technoeconomic scenario.
b. Concept and definitions: Single Sampling, Double Sampling, Multiple sampling plans, AQL, LTPD, Type A and Type B OC function, ASN, AOQL and ATI for acceptance rectification plans.
c. Sampling Schemes: Dodge & Romigs system of AOQL and LTPD plans; Sampling plans based on OC functions; Military Standards (105 D and 105 E)

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

REFERENCES

1. Introduction to Statistical Quality Control, 5th Edition: By D.C.Montgomery, Wiley, N.Y.
2. Statistical Quality Control 6th edition: By E.L. Grant & R.S. Leavenworth, McGraw Hill, N.Y.
3. Quality Control and Industrial Statistics 5th edition: By A.J. Duncan, Irwin, Homewood, Ill.
4. Quality Control and Statistical Methods: By Edward M. Schrock, Asia Publishing House.
5. Statistical Process Control, Theory and Practice: By G.B. Wetherill & D.W. Brown, Chapmann & Hall, N.Y.
6. Dodge, H.F. and Romig, H. G. (1941). Single sampling and double sampling inspection tables. Bell Syst. Tech. J., 20, 1 61; reprinted in Dodge, H. F. and Romig, H. G. (1959). Sampling Inspection Tables, 2nd edn, Wiley, New York.
7. MIL STD 105D (1963). Sampling Procedures and Tables for Inspection by Attributes, U.S. Government Printing Office, Washington D.C

K.K.

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U18EIE0021	HYBRID AND ELECTRIC VEHICLES		L	T	P	J	C
			3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify the basic components of hybrid and elective vehicles

CO2: Assess the characteristics and performance of the electric vehicle and select suitable electric propulsion and control systems for HEV

CO3: Choose proper energy storage systems for vehicle applications

CO4 : Describe the operation of fuel cell and solar cell vehicles

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	M				S		M	S		M		M
CO2	S	S	M	M			S		S	S		S		S
CO3	S	S	M	M			S	S	S	M				S
CO4	S	S	S	M			S	S	S	M				S

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End Semester Theory

Course Content:

ELECTRIC PROPULSION SYSTEMS **8 Hrs**

Drive systems for EV & HEV, DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, drive system efficiency - Control System principles, Speed and Torque control, Power electronic converters for HEV, Regenerative Braking. **ENERGY STORAGE SYSTEMS** **8 Hrs**

Requirements in Hybrid and Electric Vehicles, Types of batteries – lead acid batteries, nickel based batteries, and lithium based batteries - Battery Charging, Battery Characterization - capacity, discharge rate, state of charge, state of discharge, depth of Discharge, Technical characteristics, battery pack design, battery management system, Ultra capacitors.

ELECTRIC VEHICLES **7 Hrs**

History of electric vehicles, social importance of electric mobility, performance of e-vehicles - tractive effort and transmission requirements, vehicle performance, energy consumption, Specifications - System Components, Electric drive-trains topologies, power flow control in electric drivetrain, fuel efficiency analysis.

HYBRID VEHICLES **7 Hrs**

K.K.

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History of hybrid vehicles, social and environmental importance of hybrid vehicles, impact of modern drivetrain on energy supplies. Hybrid Electric Drive-train configurations - basic concept of hybrid traction, architecture - merits and challenges, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

HEV PERFORMANCE **8 Hrs**

Maximum speed - Acceleration – Gradeability, HEV - mechanics, efficiency, driving cycles, regulations, sizing the propulsion motor and power electronics, Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV), Vehicle Simulation, Comparison of ICEV and HEV, Well-to-Wheel Analysis.

FUEL CELL AND SOLAR VEHICLES **7 Hrs**

Operations and Properties of Fuel cells – Phosphoric Acid Fuel cell, Hydrogen Fuel cell, Proton Exchange membrane Fuel cell, Direct Methanol fuel cell Alkaline Fuel Cells, Solid Oxide Fuel Cell, Molten Carbonate Fuel Cell – Characteristics, electrochemical energy conversion – factors affecting electrochemical energy conversion - Solar Vehicles - photovoltaic cells, tracking, efficiency, and cost comparison.

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

REFERENCES

1. "Electric and Hybrid – Electric Vehicles" - Ronald K Jurgen,, SAE International, 2011.
2. "Electric and Hybrid Vehicles- Design Fundamentals" - Iqbal Husain, CRC Press, 2011.
3. "Electric Vehicle Technology Explained" - James Larminie, John Lowry, Wiley, 2012.
4. "Electric Vehicle Battery Systems" - Sandeep Dhameja, Butterworth – Heinemann, 2002.
5. "Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design" - Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, CRC Press, 2018.
6. "Fuel Cells Principles and Applications" - Viswanathan, B. and AuliceScibioh, M., Universities Press (India) Pvt. Ltd., Hyderabad, 2006.
7. "Light Weight Electric Hybrid Vehicle Design" - Ron Hodkinson and John Fenton, Butterworth – Heinemann, 2009.

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U18EIE0022	Smart Instrumentation and IoT for Industrial Automation	

L	T	P	J	C
3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Apply knowledge of field instrumentation, IoT, and smart sensor technologies to design industrial automation systems.

CO2: Demonstrate the ability to integrate field instruments, smart sensors, and IoT devices for data-driven industrial solutions.

CO3: Analyze and troubleshoot issues in the integration and operation of smart instrumentation and IoT systems in industrial settings.

CO4 : Evaluate the impact of smart instrumentation and IoT on industrial efficiency, reliability, and security.

CO5: Predict future trends and advancements in smart instrumentation and IoT technologies for industrial applications.

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	2	-	-	-	-	-	-	-	-	-	1	-
CO2	-	1	-	-	1	-	-	-	-	-	-	-	-	1
CO3	-	-	-	2	-	1	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	1	1	-	-	-	-	-	-
CO5	-													

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End Semester Theory

Course Content:

BOS Chairman

Course Content:

INTRODUCTION TO FIELD INSTRUMENTATION **9Hrs**

Basics of field instrumentation and measurement principles- Types of field instruments: -pressure, temperature, flow, and level sensors - Instrument calibration techniques and standards- Maintenance and troubleshooting of field instruments- Case studies of field instrumentation applications in various industries.

FUNDEMENTALS OF IoT **9 Hrs**

Overview of IoT and its role in industrial automation - IoT architectures and communication protocols - Data acquisition and integration from IoT devices - Security considerations in IoT implementations.- Case studies on IoT applications in industrial settings.

SMART SENSORS AND THEIR APPLICATIONS **9 Hrs**

Types of smart sensors and their features-Integration of smart sensors with IoT systems- Data processing and analytics from smart sensors- Application scenarios and case studies of smart sensors in industry- Future trends and advancements in smart sensor technology.

DATA ANALYTICS FOR INDUSTRIAL AUTOMATION **9 Hrs**

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Introduction to data analytics and its significance in industrial automation -Techniques for processing and analyzing large volumes of industrial data- Predictive analytics and machine learning applications in automation-Visualization and reporting of data analytics results - Case studies of data analytics driving improvements in industrial operations.

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ADVANCED TOPICS IN SMART INSTRUMENTATION **9 Hrs**

Emerging technologies in smart instrumentation and their applications. - Integration of advanced smart instruments with cloud computing and edge computing - Challenges and solutions in implementing advanced instrumentation technologies - Case studies and research trends in smart instrumentation-Future directions and innovations in the field.

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

REFERENCES

1. **Industrial Instrumentation and Control** - S.K. Singh, Tata McGraw-Hill Education, 2009.
2. **Smart Sensors and MEMS: Intelligent Sensing Devices and Microsystems for Industrial Applications** - S. Nihtianov, A. Luque, Woodhead Publishing, 2018.
3. **The Internet of Things: Key Applications and Protocols** - David Boswarthick, Omar Elloumi, Olivier Hersent, Wiley, 2012.
4. **Industrial Automation and Control System Security Principles** - Ronald L. Krutz, Wiley, 2013.
5. **Data Analytics for the Internet of Things** - Andrew Minteer, Packt Publishing, 2017.

BOS Chairman

U18EIE0023	Machine Learning for Industrial Automation	L	T	P	J	C
		3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Apply machine learning techniques to solve problems in industrial instrumentation.

CO2: Implement supervised and unsupervised learning models for industrial data analysis and fault detection

CO3: Analyze the effectiveness of various machine learning algorithms in optimizing industrial processes.

CO4 : Utilize reinforcement learning for process control and automation in industrial settings.

CO5: Evaluate emerging trends and advanced techniques in machine learning for industrial applications.

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	2	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	3	-	-	-	-	-	-	-	3	-
CO3	2	2	-	-	2	-	-	-	-	-	-	-	3	-
CO4	2	2	-	-	2	-	-	-	-	-	-	-	-	3
CO5	3	2	-	-	2	-	-	-						

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End Semester Theory

Course Content:

Course Content:

INTRODUCTION TO MACHINE LEARNING FOR INDUSTRAIL APPLICATIONS9Hrs

Overview of machine learning (ML) and its relevance in industrial instrumentation - Types of machine learning: supervised, unsupervised, and reinforcement learning - Data collection and preprocessing for ML in industrial settings - Feature engineering and selection for industrial data - Introduction to key ML algorithms used in industrial applications.

SUPERVISED LEARNING FOR INDUSTRIAL INSTRUEMNATATION 9 Hrs

Overview of supervised learning and its applications in industrial settings - Linear regression, logistic regression, and their applications in instrumentation - Decision trees, random forests, and their use in fault detection and prediction - Support vector machines (SVM) for classification tasks in industrial environments - Case studies on the application of supervised learning in industrial instrumentation.

UN SUPERVISED LEARNING AND ANALOMY DETECTION 9Hrs

Introduction to unsupervised learning and its importance in industrial instrumentation - Clustering techniques: k-means, hierarchical clustering, and their applications - Principal component analysis (PCA) for dimensionality reduction in industrial data - Anomaly detection techniques and their use in predictive maintenance - Case studies on unsupervised learning and anomaly detection in industrial environments.

REINFORCEMENT LEARNING AND OPTIMIZATION 9 Hrs

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Overview of reinforcement learning and its application in industrial control systems - Markov decision processes and their role in reinforcement learning - Q-learning and policy gradient methods for optimizing industrial processes - Applications of reinforcement learning in process control and automation -Case studies on reinforcement learning in industrial optimization.

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ADVANCED TOPICS FOR MACHINE LEARNING IN INSTRUMENTATION

9 Hrs

Emerging trends in machine learning for industrial applications - Deep learning and its use in complex industrial instrumentation tasks - Integration of ML with IoT and edge computing in industrial settings - Challenges and solutions in deploying ML models in industrial environments - Future directions and innovations in ML for industrial instrumentation

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

REFERENCES

1. Machine Learning: A Probabilistic Perspective - Kevin P. Murphy, MIT Press, 2012.
2. Pattern Recognition and Machine Learning - Christopher M. Bishop, Springer, 2006.
3. Machine Learning for Asset Management - Emmanuel A. Blanchard, Apress, 2021.
4. Industrial Applications of Machine Learning - Pedro Larrañaga, César García-Osorio, Manuel Martín-Merino, CRC Press, 2019.
5. Introduction to Machine Learning with Python: A Guide for Data Scientists – Andreas C. Müller, Sarah Guido, O'Reilly Media, 2016.

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U18EIE0024	Industrial Safety and Hazardous Systems		L	T	P	J	C
			3	0	0	0	3

Course Outcomes (CO):

After Successful completion of this course, the students will be able to :

CO1: Identify occupational health hazards in industrial environments.

CO2: Apply PPE and safety training in workplace safety programs

CO3: Utilize ergonomics to improve safety and efficiency in the workplace

CO4 : Implement safety audits and ensure compliance with health regulations..

CO5: Analyze incident reports to improve occupational safety practices

Pre-requisite: Nil

COs	PO												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2		2	2						2	3
CO2		2	2				2						3	3
CO3			2			2	2						3	3
CO4		2	2	2		2							3	3
CO5		2		2			2						3	3

Course Assessment Methods:

Direct

- Internal Tests
- Assignment
- End Semester Theory

Course Content:

INTRODUCTION TO INDUSTRIAL SAFETY **9Hrs**

Overview of Industrial Safety and its Importance- Types of Industrial Hazards (Mechanical, Electrical, Chemical, etc.) - Safety Standards and Regulations (OSHA, ISO) -Risk Assessment and Management Techniques- Safety Instrumented Systems (SIS) and Safety Integrity Levels (SIL)

HAZARDOUS SYSTEMS AND RISK MANAGEMENT **9Hrs**

Types of Hazardous Systems in Industries - Fault Tree Analysis (FTA) and Event Tree Analysis (ETA) - Failure Modes and Effects Analysis (FMEA)- Risk Matrix and Hazard Operability Study (HAZOP) - Emergency Planning and Response.

SAFETY IN PROCESS CONTROL AND INSTRUMENTATION **9Hrs**

Safety Considerations in Process Control Systems - Role of Sensors and Actuators in Safety Systems - Redundancy and Reliability in Instrumentation - Functional Safety of Safety-Critical Systems - Safety Compliance in Control System Design

FIRE AND EXPLOSION PREVENTION IN INDUSTRIES **9Hrs**

Causes and Consequences of Fires and Explosions-Fire Detection and Suppression Systems- Explosion Protection Techniques (Inerting, Venting)- Safety Measures in Flammable and Combustible Material Handling - Case Studies on Industrial Fires and Explosions

OCCUPATIONAL HEALTH AND SAFETY IN INDUSTRIES **9Hrs**

BOS Chairman

Occupational Health Hazards (Chemical, Biological, Physical)- Personal Protective Equipment (PPE) and Safety Training - Ergonomics and Human Factors in Industrial Safety - Health and Safety Audits and Compliance - Incident Reporting and Investigation Techniques		
Theory Hours: 45	**Practical Hours:**	**Total Hours: 45**

REFERENCES

1. **Industrial Safety and Health Management** - C. Ray Asfahl, David W. Rieske, Pearson, 219.
2. **Principles of Fire Behavior and Combustion** - Richard Gann, Raymond Friedman, Jones & Bartlett Learning, 214.
3. **Guidelines for Hazard Evaluation Procedures** - CCPS (Center for Chemical Process Safety), Wiley, 212.
4. **Safety Instrumented Systems: Design, Analysis, and Justification** - Paul Gruhn, Harry Cheddie, ISA, 26.
5. **Occupational Health and Safety Management: A Practical Approach** - Charles D. Reese, CRC Press, 215

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