Puducherry Technological University, Puducherry –605014

(A Technological University of Government of Puducherry)

Curriculum and Syllabi

for

B.Tech.(Electrical and Electronics Engineering)

(Effective from Academic year 2024-25)

(Subject to the Approval of the Fifth Academic Council meeting of Puducherry Technological University)

CURRICULUM AND SYLLABUS

The Curriculum of B.Tech. (Electrical and Electronics Engineering) is designed to fulfil the Program Educational Objectives (PEO) and the Program Outcomes (PO) listed below.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1	**Strong Theoretical and Practical Foundation** To equip students with a strong foundation in Electrical and Electronics Engineering principles and to develop skills through practical training, thereby enhancing them to design, analyse, debug, Electrical systems.
PEO2	**Technical Excellence, Leadership and Global Competence** To develop the competence to analyse and devise effective solutions for real-world challenges in the power, control, and electronics sectors and to pursue innovative and interdisciplinary research, contributing to sustainable development in globally competitive environment.
PE03	**Lifelong Learning, Ethical Practice, and Social Impact** To cultivate a strong commitment to lifelong learning with ethics and standards, apply their knowledge responsibly, to enhance the quality of life through their engineering practice.

PROGRAM OUTCOMES (PO)

PO1	**Engineering Knowledge:** Apply the knowledge of Mathematics, Natural science, Computing, Engineering Fundamentals and an Engineering Specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems
PO2	**Problem Analysis:** Identify, formulate review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1-WK4)
PO3	**Design / Development of solutions:** design creative solutions for complex engineering problems and design / develop systems / components / processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).
PO4	**Conduct Investigations of complex problems:** Conduct investigations of complex engineering problems using research based knowledge including design of experiments, modelling, analysis and interpretation of data to provide valid conclusions. (WK8).
PO5	**Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 & WK6).
PO6	**The Engineer and the world**: Analyse and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5 and WK7).
PO7	**Ethics:** Apply ethical principles and commit to professional ethics, human values. Diversity and inclusion, adhere to national and international laws. (WK9).
PO8	**Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse / multi-disciplinary teams.
PO9	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective

	reports and design documentations, make effective presentations considering cultural, language, and learning differences
PO10	**Project Management and Finance**: Apply knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-long learning**: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1	Apply the fundamentals of Mathematics, Science and Engineering knowledge to design and analyse the novel solution to the real life problems related to power grid, renewable energy systems, electric vehicles, micro grid and electronic circuitry.
PSO2	Apply the appropriate techniques and modern engineering tools in electrical and electronics engineering to engage in lifelong learning and to successfully adapt in multi-disciplinary environment.
PSO3	Develop the competence to provide professional electrical engineering solutions as per the needs of society and industry.

Distribution of credits among the subjects grouped under various categories:

Courses are grouped under various categories and the credits to be earned in each category of courses are as follows:

Sl. No.	Category	Credits	Course Category Code (CCC)
1	Basic Science Courses	20	BSC
2	Engineering Science Courses	10.5	ESC
3	Professional Core Courses	85.5	PCC
4	Professional Elective Courses	12	PEC
5	Ancillary Stream Courses	12	ANC
6	Ability Enhancement Courses	10	AEC
7	Skill Enhancement Courses	8	SEC
8	Value Added Courses	4	VAC
	Total	**162**	

Semester-wise Courses and Credits

Semester I

Course Code	Course	CCC	Periods			Credits
			L	T	P	
	Three weeks compulsory Induction Program					
MAUC101	Mathematics I	BSC	3	1		4
EEUC101	Elements of Electrical Engineering	PCC	3	1		4
CYUC101	Chemistry	BSC	3			3
CSUC101	Programming for Problem Solving	ESC	2			2
HSUA101	English for Communication	AEC	2			2
GEUS102	Basic Engineering Skills Laboratory - II	SEC	1		4	3
GEUV102	Essence of Indian Traditional Knowledge	VAC	1			1
CYUC102	Chemistry Laboratory	BSC			2	1
CSUC102	Computer Programming Laboratory	ESC			2	1
Total			15	2	8	
			25			21

CCC - Course Category Code, L-Lecture, T – Tutorial, P – Practical

Semester II

Course Code	Course	CCC*	Periods			Credits
			L	T	P	
MAUC102	Mathematics II	BSC	3	1		4
EEUC102	Electronic Devices and Circuits	PCC	3	1		4
PHUC101	Physics	BSC	3			3
MEUC101	Engineering Graphics	ESC	1		4	3
HSUA102	Professional English	AEC	2			2
GEUS102	Basic Engineering Skills Laboratory - I	SEC	1		4	3
GEUV101	NSS, Yoga and Health	VAC			2	1
PHUC102	Physics Laboratory	BSC			2	1
Total			13	2	12	
			27			21

Exit Option for the students who opt to exit after completion of first year of B.Tech Programme and have secured a minimum of 42 credits will be awarded a UG certificate in a discipline if, in addition they complete one vocational course of 4 credits during the summer vacation of the first year.

Semester III

Course Code	Course	CCC	Periods			Credits
			L	T	P	
MAUC104	Transforms and Partial Differential Equations	BSC	3	1		4
EEUC103	Electric Circuit Analysis	PCC	2	1		3
EEUC104	Signals and Systems	PCC	4			4
EEUC105	Analog Electronics	PCC	3			3
EEUC106	DC Machines and Transformers	PCC	2	1		3
HSUA103	Entrepreneurship	AEC	2			2
GEUV103	Environmental Education	VAC	1			1
EEUC107	Electronic Devices and Circuits Laboratory	PCC			3	1.5
EEUC108	DC Machines and Transformers Laboratory	PCC			3	1.5
Total			17	3	6	-
			26			23

Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EEUC109	Control Systems	PCC	3	1		4
EEUC110	Digital Electronics	PCC	3			3
EEUC111	AC Machines	PCC	2	1		3
CSUC137	Data Structure and Object Oriented Programming	ESC	3			3
HSUA104	Modern Indian Language/Foreign language (or) Design Thinking	AEC	2			2
GEUV104	Universal Human values	VAC	1			1
EEUC112	Digital Electronics Laboratory	PCC			3	1.5
EEUC113	AC Machines Laboratory	PCC			3	1.5
CSUC138	Data Structure and Object Oriented Programming Laboratory	ESC			3	1.5
Total			14	2	9	
			25			20.5

Course Code	Course	CCC	Periods			Credits
			L	T	P	
	Ancillary Stream Course 1	ANC	3			3
EEUH101	Network Analysis and Synthesis	HNC	3	1		4

Exit Option for the students who opt to exit after completion of second year of B.Tech Programme and have secured a minimum of 88.5 credits will be awarded a UG Diploma in a discipline if, in addition they complete one vocational course of 4 credits during the summer vacation of the second year.

Semester V

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EEUC114	Power Electronics	PCC	3			3
EEUC115	Linear Integrated Circuits	PCC	3			3
EEUC116	Transmission and Distribution	PCC	3			3
EEUC117	Measurements and Instrumentation	PCC	3			3
HSUA105	Industrial Economics and Management	AEC	2			2
EEUEXXX	Professional Elective 1	PEC	3	1		4
EEUC118	Linear Integrated Circuits Laboratory	PCC			3	1.5
EEUC119	Measurements and Control Laboratory	PCC			3	1.5
Total			17	1	6	
			24			21

Course Code	Course	CCC	Periods			Credits
			L	T	P	
	Ancillary Stream Course 2	ANC	3			3
EEUH102	Advanced Control Systems	HNC	3	1		4

Semester VI

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EEUC120	Power System Analysis	PCC	3			3
EEUC121	Microprocessors and Microcontrollers	PCC	3			3
EEUC122	Artificial Intelligence	PCC	3			3
EEUEXXX	Professional Elective 2	PEC	3	1		4
EEUC123	Microprocessors and Microcontrollers Laboratory	PCC			3	1.5
EEUC124	Power Electronics Laboratory	PCC			3	1.5
EEUC125	Internship	SEC				2
Total			12	1	6	
			19			18

Course Code	Course	CCC	Periods			Credits
			L	T	P	
	Ancillary Stream Course 3	ANC	3			3
EEUH103	Power Electronics in Power Systems	HNC	3	1		4

Exit Option for the students who opt to exit after completion of third year of B.Tech Programme and have secured a minimum of 133.5 credits will be awarded a B.Sc. (Engg.) in a discipline.

Semester VII

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EEUC126	Power System Operation and Control	PCC	3			3
EEUC127	Protection and Switchgear	PCC	3			3
EEUC128	Solid State Drives	PCC	3			3
EEUEXXX	Professional Elective 3	PEC	3	1		4
EEUC129	Power Systems Laboratory	PCC			3	1.5
EEUC130	Mini Project	PCC			4	2
EEUC131	Comprehensive Viva	PCC				1
Total			12	1	7	
			20			17.5

Course Code	Course	CCC	Periods			Credits
			L	T	P	
	Ancillary Stream Course 4	ANC	3			3
EEUH104	Design and Modelling of Hybrid Energy Systems	HNC	3	1		4

XXX – Professional Elective Serial Number

Semester VIII

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EEUC132	Project Work	PCC			16	8
Total					16	
			16			8

Course Code	Course	CCC	Periods			Credits
			L	T	P	
EEUH105	Honours Course 5 (Seminar)	HNC			4	2

List of Professional Elective Courses

Professional Elective	Course code	Course	**Semester**
Professional Elective I	EEUE101	Fuzzy Logic and Neural Networks	**V**
	EEUE102	Digital Signal Processing	
	EEUE103	Modern Control Theory	
	EEUE104	Special Electrical Machines	
	EEUE105	Power Generation Systems	
Professional Elective II	EEUE106	Digital Control Systems	**VI**
	EEUE107	Electric and Hybrid Vehicles	
	EEUE108	Electrical Safety and Quality Management	
	EEUE109	Renewable Energy	
	EEUE110	Utilization of Electrical Energy	
	EEUE111	Distributed Generation	
	EEUE112	High Voltage Engineering	
Professional Elective III	EEUE113	Embedded Systems	**VII**
	EEUE114	Electric Power Quality	
	EEUE115	FACTS Controllers	
	EEUE116	High Voltage Direct Current Transmission	
	EEUE117	Power System Restructuring and Deregulation	
	EEUE118	Smart Grid	
	EEUE119	Big Data Analytics in Power Systems	

Ancillary stream Elective courses:

Ancillary Stream Elective Title 1: **Green Energy** (For other Department students)	
Course code	Course Name
EEUN101	Renewable Energy Technologies and Grid Integration
EEUN102	Power Converters for Renewable Energy Systems
EEUN103	Distributed Generation and Energy Storage
EEUN104	Energy Management and Energy Audit

Ancillary Stream Elective Title 2: **Electric Vehicle Technology** (For other Department students)	
Course code	Course Name
EEUN105	Hybrid Electric Vehicles
EEUN106	Battery Management Systems
EEUN107	Electric Vehicle Power Train
EEUN108	Electric Vehicle Diagnostics System

Ancillary Stream Elective Title 3: **Power Engineering** (For other Department students)	
Course code	Course Name
EEUN109	Fundamentals of Power Systems

EEUN110	Power Markets and Exchanges
EEUN111	Smart System Automation
EEUN105	Hybrid Electric Vehicles

Ancillary Stream Elective Title 1: **Industrial Instrumentation** (Interdisciplinary-For students of EEE Department)	
Course code	Course Name
EEUI101	Sensors and Transducers
EEUI102	Industrial Automation
EEUI103	Internet of Things
EEUI104	Industry 4.0

Ancillary Stream Elective Title 2: **Computer Networks and Problem solving** (Interdisciplinary-For students of EEE Department)	
Course code	Course Name
EEUI103	Internet of Things
EEUI105	Optimization Techniques
EEUI106	Soft Computing
EEUI107	Computer Networks

Courses offered under various categories:

CCC	Course Code	Course	Semester	Credit	Total Credit
BSC	MAUC101	Mathematics – I	I	4	20
	PHUC101	Physics	II	3	
	CYUC101	Chemistry	I	3	
	PHUC102	Physics laboratory	II	1	
	CYUC102	Chemistry Laboratory	I	1	
	MAUC102	Mathematics –II	II	4	
	MAUC104	Transforms and Partial Differential Equations	III	4	
ESC	MEUC101	Engineering Graphics	II	3	10.5
	CSUC101	Programming for Problem Solving	I	2	
	CSUC102	Computer Programming Laboratory	I	1	
	CSUC137	Data Structure and Object Oriented Programming	IV	3	
	CSUC138	Data Structure and Object Oriented Programming Laboratory	IV	1.5	
PCC	EEUC101	Elements of Electrical Engineering	I	4	85.5
	EEUC102	Electronic Devices and Circuits	II	4	
	EEUC103	Electric Circuit Analysis	III	3	
	EEUC104	Signals and Systems	III	4	
	EEUC105	Analog Electronics	III	3	
	EEUC106	DC Machines and Transformers	III	3	
	EEUC107	Electronic Devices and Circuits Laboratory	III	1.5	
	EEUC108	DC Machines and Transformers Laboratory	III	1.5	
	EEUC109	Control Systems	IV	4	
	EEUC110	Digital Electronics	IV	3	
	EEUC111	AC Machines	IV	3	
	EEUC112	Digital Electronic Laboratory	IV	1.5	
	EEUC113	AC Machines Laboratory	IV	1.5	
	EEUC114	Power Electronics	V	3	
	EEUC115	Linear Integrated Circuits	V	3	
	EEUC116	Transmission and Distribution	V	3	
	EEUC117	Measurements and Instrumentation	V	3	
	EEUC118	Linear Integrated Circuits Laboratory	V	1.5	
	EEUC119	Measurements and Control Laboratory	V	1.5	
	EEUC120	Power System Analysis	VI	3	
	EEUC121	Microprocessors and Microcontrollers	VI	3	
	EEUC122	Artificial Intelligence	VI	3	
	EEUC123	Microprocessors and Microcontrollers Laboratory	VI	1.5	
	EEUC124	Power Electronics Lab	VI	1.5	
	EEUC126	Power System Operation and Control	VII	3	
	EEUC127	Protection and Switchgear	VII	3	

	EEUC128	Solid State Drives	VII	3	
	EEUC129	Power Systems Laboratory	VII	1.5	
	EEUC130	Mini Project	VII	2	
	EEUC131	Comprehensive Viva	VII	1	
	EEUC132	Project Work	VIII	8	
PEC	EEUE101	Fuzzy Logic and Neural Networks	V	4	**12**
	EEUE102	Digital Signal Processing	V	4	
	EEUE103	Modern Control theory	V	4	
	EEUE104	Special Electrical Machines	V	4	
	EEUE105	Power Generation Systems	V	4	
	EEUE106	Digital Control Systems	VI	4	
	EEUE107	Electric and Hybrid Vehicles	VI	4	
	EEUE108	Electrical Safety and quality management	VI	4	
	EEUE109	Renewable Energy	VI	4	
	EEUE110	Utilization of Electrical Energy	VI	4	
	EEUE111	Distributed Generation	VI	4	
	EEUE112	High Voltage Engineering	VI	4	
	EEUE113	Embedded Systems	VII	4	
	EEUE114	Electric Power Quality	VII	4	
	EEUE115	FACTS Controllers	VII	4	
	EEUE116	High Voltage Direct Current Transmission	VII	4	
	EEUE117	Power System Restructuring and Deregulation	VII	4	
	EEUE118	Smart Grid	VII	4	
	EEUE119	Big Data Analytics in Power Systems	VII	4	
AEC	HSUA101	English for Communication	I	2	**10**
	HSUA102	Professional English	II	2	
	HSUA103	Modern Indian/Foreign Language (or) Design Thinking	III/IV	2	
	HSUA104	Entrepreneurship	II/IV	2	
	HSUA105	Industrial Economics and Management	V/VI	2	
SEC	GEUS101	Basic Engineering Skills Laboratory - I	I/II	3	**8**
	GEUS102	Basic Engineering Skills Laboratory - II	I/II	3	
	EEUC125	Internship	VI	2	
VAC	GEUV101	NSS, Yoga and Health	I/II	1	**4**
	GEUV102	Essence of Indian Traditional Knowledge	I/II	1	
	GEUV103	Environmental Education	III/IV	1	
	GEUV104	Universal Human Values	III/IV	1	
ANC		Ancillary Stream Elective course	**IV-VII**	12	**12**
Total					**162**

Annexure I

Syllabus of B. Tech. (Electrical and Electronics Engineering)

Programme Core Courses

Department : **Mathematics**			Programme : **B.Tech - EEE**						
Semester : **Third**			Subject Category: **BSC**			Exam Type: TY			
Course Code	Course Name		Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
MAUC104	**Transforms and Partial Differential Equations**		3	1	-	4	40	60	100
Prerequisite:									
Course Outcome: At the end of the course, the students will be able to	**CO1**	Explain the concept of Laplace Transform and its inverse.							
	CO2	Utilize Laplace Transform to solve the ODEs.							
	CO3	Analyze various methods of solving first order PDE.							
	CO4	Determine the solution of higher order PDE and applying the method of variable separation to solve wave equation.							
	CO5	Make use of Fourier series method to solve heat equations.							

UNIT-I	**LAPLACE TRANSFORMS**	**Periods: 12**
Definition of Laplace Transform, Inverse Laplace Transform, Linearity property, Laplace transform of unit step function, Unit impulse function and some elementary functions, Change of scale and first shifting property, Laplace transform of Periodic functions		**CO1**
UNIT-II	**APPLICATIONS OF LAPLACE TRANSFORMS**	**Periods: 12**
Derivatives and integrals of Laplace transform, Transform of derivatives and integrals, Application: Solution of single ordinary linear differential equation with constant coefficients, Initial and Final value theorem.		**CO1, CO2**
UNIT-III	**PARTIAL DIFFERENTIAL EQUATIONS**	**Periods: 12**
General and Singular solution of PDE, Complete Solution of First order linear and Non-linear PDE, First order linear PDE - method of grouping and Lagrange's multipliers method.		**CO3**
UNIT-IV	**HIGHER ORDER PDE AND BOUNDARY VALUE PROBLEMS**	**Periods: 12**
Homogeneous linear PDE of higher order with constant coefficients. Solution of partial differential equation by the method of separation of variables. Application of PDE: Variable separable solutions of the one dimensional wave equation, Transverse vibration of a stretched string.		**CO3, CO4**
UNIT-V	**ONE DIMENSIONAL AND TWO DIMENSIONAL HEAT FLOW EQUATION**	**Periods: 12**
Heat Equation, Solution of one dimensional heat equation by the method of separation of variables, Temperature distribution with zero and non-zero boundary values, Two dimensional heat flow under steady state conditions(Cartesian).		**CO3, CO4, CO5**

Total contact Hours: 45	**Total Tutorials: 15**	**Total Practical Classes: 0**	**Total Hours: 60**

Reference Books:

1. Veerarajan T, Engineering Mathematics I & II, McGraw-Hill Education(India) Private Limited, 2019
2. Veerarajan T, Transforms and Partial Differential Equations, Third Edition, McGraw-Hill Education(India) Private Limited, 2016.
3. Venkataraman M.K., Engineering Mathematics, Third Year, Part-B, The National Publishing Company, Chennai, 2008.
4. Erwin Kreyszig, Advanced Engineering Mathematics (9 th Ed), John Wiley & Sons, New Delhi, 2011.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, Eleventh Reprint, 2010.
6. Bali N. and Goyal M., Advanced Engineering Mathematics, Laxmi Publications Pvt. Ltd., New Delhi, 9thEdition, 2011.
7. B.S. Grewal "Higher Engineering Mathematics" (44th Ed), Khanna Publishers, 2018.

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	3	2	1	2	3	1	-	1	2	1	2
CO2	3	3	2	3	3	1	-	1	2	1	2
CO3	3	3	2	3	3	2	-	1	2	1	2
CO4	3	3	2	3	3	2	-	1	2	1	2
CO5	3	3	2	3	3	2	-	1	2	1	2

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Third**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC103	**Electric Circuit Analysis**	2	1	-	3	40	60	100
Prerequisite:	Elements of Electrical Engineering							

Course Outcome: At the end of the course, the students will be able to		
	CO1	**Apply and analyse electrical circuits with DC excitation**, including dependent and independent sources, using network theorems, as well as super mesh and super node analysis.
	CO2	Examine and evaluate electrical circuits with AC excitation using network theorems effectively.
	CO3	Assess the time response behaviour of electrical circuits under DC and AC excitation using the Laplace transform.
	CO4	**Understand coupled circuit analysis** and examine the behaviour of resonant series/parallel RL, RC, and RLC circuits.
	CO5	**Study unbalanced three-phase circuits, two-port networks, and network topology** for comprehensive circuit analysis.

UNIT-I	**Theorems for DC circuits**	**Periods: 9**
Maximum power transfer theorem, Millman's theorem - Mesh analysis and Nodal Analysis with Dependent current and voltage sources. Super Mesh Analysis – Super Node Analysis		**CO1**
UNIT-II	**Theorems for AC circuits**	**Periods: 9**
Superposition theorem, Thevenin's Theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem.		**CO1, CO2**
UNIT-III	**Time Response Analysis of Electric Circuits**	**Periods: 9**
Natural and Forced Response – Analysis of time response behavior of Series/Parallel RL, RC & RLC circuits with Step, Ramp, Exponential and Sinusoidal inputs. Solution using Laplace Transforms.		**CO1, CO3**
UNIT-IV	**Coupled and Resonance Circuits**	**Periods: 9**
Coupled circuits: Self and Mutual inductance – coefficient of coupling – Dot convention – Equivalent Inductance in series and parallel coupled circuits - Single tuned and Double tuned circuits. Resonant circuits- Series and parallel resonance circuits, Resonant frequency – Bandwidth - Quality Factor Q - effect of Q on resonance. Relations between Q, resonant frequency and bandwidth		**CO4**
UNIT-V	**Three Phase Circuits, Two Port Networks and Network Topology**	**Periods: 9**
Three phase balanced system with unbalanced load – Analysis of three phase 3 wire and three phase 4 wire circuits with star and delta connected unbalanced loads along with their phasor diagram of voltages and currents. **Two Port Networks**: Two Port Networks, terminal pairs, relationship of two port variables, Impedance parameters, Admittance parameters, and Hybrid parameters, Interconnections of two port networks. Network Topology- Types of graphs- subgraph, Tree, Co-tree, Incidence matrix, Cut set matrix, Tie-set matrix.		**CO1, CO5**

Lecture Periods: 30	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. "Engineering Circuit Analysis" by William H. Hayt Jr., Jack E. Kemmerly, and Steven M. Durbin: 10th Edition: McGraw Hill , 2023.
2. "Electric Circuits Theory" by Joseph A. Edminister: 6th Edition : Schaum's Outline series by Tata McGraw Hill, 2014
3. "Electric Circuit Analysis" by P. Ramesh Babu: Scitech Publications (India) Pvt Ltd 2010
4. "Electric Circuit Analysis" by A. Sudhakar and Shyammohan S. Palli: 5th Edition McGraw Hill Education, 2017.
5. "Fundamentals of Electric Circuits" by Charles K. Alexander and Matthew N. O. Sadiku:2nd Edition Tata McGraw Hill 2013.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	-	-	1	-	1	2	1	-	
CO2	3	3	2	2	1	-	-	-	1	-	1	2	1	-	
CO3	3	3	3	3	1	-	-	-	1	-	1	2	1	-	
CO4	3	3	3	3	2	-	-	-	1	-	1	2	1	-	
CO5	3	3	2	2	1	-	-	-	1	-	1	2	1	-	

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Third**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC104	**Signals and Systems**	3	1	-	4	40	60	100
Prerequisite:	Mathematics I, Mathematics II							

Course Outcome At the end of the course, the students will be able to		
	CO1	Assess the basic concepts in the representation and interpretation of signals and systems.
	CO2	Analyze continuous-time signals using Fourier series (periodic signals), Fourier transforms (aperiodic signals) and Laplace transforms.
	CO3	Apply the concepts of convolution integral in the process of modelling of continuous-time system using time-invariant differential equations leading to transfer function models.
	CO4	Evaluate discrete-time signals using Fourier series (periodic signals), Fourier transforms (aperiodic signals) and z-transforms.
	CO5	Use the concepts of convolution summation in the process of modelling of continuous-time system using time-invariant difference equations culminating in pulse transfer function models.

UNIT-I	**Introduction to Signals and Systems and their Classification**	**Periods: 12**
Introduction to Signals and Systems as experienced in everyday life and in various branches of Engineering and Technology – Electrical, Mechanical, Hydraulic, Thermal and Biomedical domains etc. **Classification of Signals**: Standard Signals – Step, Ramp, Parabolic, Pulse, Impulse, Real and Complex exponentials and Sinusoidal signals – Basic operation on signals – Classification of Signals – Continuous-time and Discrete-time signals – Periodic and Aperiodic Signals; Deterministic and Random Signals; Energy and Power Signals. **Classification of Systems**: Continuous-time and Discrete-time systems – Linear and Nonlinear Systems – Time-invariant and Time-varying Systems, Causal and Non-causal Systems, Stable and Unstable Systems.		**CO1**
UNIT-II	**Analysis of Continuous-Time Signals**	**Periods: 12**
Fourier series representation of Continuous-time periodic signals – Fourier transform representation of Continuous-time non-periodic signals. Properties of Fourier representations: Linearity, Symmetricity, Convolution property, Differentiation and Integration properties, Time and Frequency shift properties, scaling properties and duality property Fourier transform. Laplace transform – properties – theorems – Inverse Laplace transform.		**CO1, CO2**
UNIT-III	**Linear Continuous-Time Systems**	**Periods: 12**
Continuous-time Systems – Linearity and Time-invariance properties – Convolution integral – transfer function model - block diagrammatic representation of LTI systems – various interconnection patterns of LTI systems. Differential equation representation of LTI system – solution – computation of natural and forced response for a standard test input signal. State variable representation of linear continuous-time systems.		**CO1, CO3**
UNIT-IV	**Analysis of Discrete-Time Signals**	**Periods: 12**
Fourier series representation of Discrete-time periodic signals – Discrete-time Fourier transform representation of Discrete-time non-periodic signals – Properties of discrete-time Fourier representations. Z-transform of discrete-time signals – properties of z-transform – inverse z-transform.		**CO2, CO4**
UNIT-V	**Linear Discrete-Time Systems**	**Periods: 12**
Discrete-time Systems - – Linearity and Time-invariance properties – Convolution summation – pulse transfer function model – solution to discrete-time difference equation – natural and forced response. State variable representation of linear discrete-time systems.		**CO1, CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, Second Edition – Reprint 2014.
2. Allan V. Oppenheim, Allan S. Willsky and S. Hamid Nawab, "Signals and Systems", Prentice-Hall India Learning, Second Edition, New Delhi, 2007.

3. I. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, “Signals and Systems”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2001.
4. Ramesh Babu, “Signals and Systems”, SciTech Publications, Chennai, 4th Edition, 2011.
5. B. P. Lathi, “Signal Processing and Linear Systems”, Oxford University Press, 1998.
6. Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, “Feedback Control of Dynamic Systems”, 8th Edition, Pearson, 2018.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	-	-	-	-	1	-	-	3	2	1
CO2	3	3	2	1	-	-	-	-	1	-	-	3	2	1
CO3	2	3	2	2	-	-	-	-	1	-	-	3	2	1
CO4	3	3	2	2	-	-	-	-	1	-	-	3	2	1
CO5	3	3	2	2	-	-	-	-	1	-	-	3	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Third**			Course Category Code: **PCC**			Semester Exam Type: **TY**			
EEUC105	**Analog Electronics**		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
			3	-	-	3	40	60	100
Prerequisite:	Electronic Devices and Circuits								
Course Outcome: At the end of the course, the students will be able to	**CO1**	**Analyze small-signal and differential amplifiers** using transistor models, including hybrid parameters and small-signal equivalent circuits, to evaluate performance in single-stage and multistage configurations.							
	CO2	**Examine the design and operation of tuned and power amplifiers**, including Class A, B, AB, C, and D configurations, to assess efficiency, frequency response, and distortion characteristics.							
	CO3	**Apply the principles of feedback amplifiers and oscillators**, utilizing concepts of negative feedback, gain stability, and Barkhausen criteria to design various types of oscillators.							
	CO4	**Design and analyze various wave-shaping and multivibrator circuits**, such as RC and RL circuits, bistable, monostable, and astable multivibrators, and relaxation oscillators using transistors and UJTs.							
	CO5	**Compare different amplifier configurations and their applications**, including CB, CE, and CC transistor amplifiers, cascode and Darlington amplifiers, and their role in practical analog circuit design.							
UNIT-I	**Small Signal Amplifiers**					**Periods: 9**			
Two port devices and hybrid model– transistor hybrid model and H-parameters – determination of H-parameters from transistor characteristics–Analysis of CB, CE and CC circuits using H-parameter model– Comparison of CB, CE and CC circuits–CE amplifier with unbiased emitter resistance. Low frequency FET model– analysis of common source circuits.									**CO1, CO5**
UNIT-II	**Differential and Multistage Amplifiers**					**Periods: 9**			
Differential amplifier – Basic BJT differential pair – Operation –small signal equivalent circuit analysis – Common mode rejection ratio – Differential and Common mode gains – Differential and common mode input impedances – Differential amplifier frequency response. Multi stage amplifier - Cascading amplifier–direct coupled and capacitor coupled two stage CE amplifiers– Darlington pair– Cascode amplifier.									**CO1, CO5**
UNIT-III	**Tuned and Large Signal Amplifiers**					**Periods: 9**			
Tuned amplifier circuits–single tuned–double tuned–stagger tuned amplifiers Classification of Power amplifiers–Class A power amplifier–direct coupled and transformer coupled–Class B amplifier–push-pull arrangement and complementary symmetry amplifiers– Conversion efficiency calculations – cross-over distortion–Class AB and class C amplifiers.									**CO2, CO5**
UNIT-IV	**Feedback Amplifiers and Oscillators**					**Periods: 9**			
Feedback concept–Gain with feedback–General characteristics of negative feedback amplifiers–Four basic types of feedback-Multistage feedback amplifiers–Two stage CE amplifier with series voltage negative feedback. Conditions for sustained oscillations– Barkhausen criterion–LC oscillators–analysis of Hartley and Colpitt types–RC oscillators–Phase shift and Wein-bridge types–analysis of the circuits– Crystal oscillators.									**CO3, CO4**
UNIT-V	**RC circuits**					**Periods: 9**			
Linear wave shaping circuits: RC, RL and RLC circuits – Bistable, monostable and astable multi-vibrators using BJT– Schmitt trigger circuit using BJT– Voltage and current sawtooth sweeps – Fixed amplitude sweep – Constant current sweep. Multivibrators using negative resistance device – UJT relaxation oscillator.									**CO3, CO4**
Lecture Periods: 45	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 45**			

Reference Books:

1. Jacob Millman and Christos C. Halkias, Electronic Devices and Circuits, Tata-McGrawHill, 2003.
2. David A Bell, Electronic Devices and Circuits, PHI, 4thEdition, 2006.
3. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice-Hall India, 2009.
4. David A Bell, Solid State Pulse Circuits, 4th Edition, PHI, 2008.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	-	-	2	-	1	2	1	-
CO2	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO3	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO4	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO5	1	2	2	3	2	-	-	-	2	-	1	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : Third		Course Category Code: PCC				Semester Exam Type: TY		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC106	**DC Machines and Transformers**	2	1	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course, the students will be able to		
	CO1	Understand the characteristics, properties and applications of magnetic field with the help of fundamental laws of fields.
	CO2	Gain knowledge about the concept, operation, speed control and characteristics of DC Machines.
	CO3	Understand various methods of starting, speed control and testing of DC machines.
	CO4	Understand the operation and analyse the characteristics of single phase transformers.
	CO5	Understand the operation and analyse the characteristics of polyphase transformers and special transformers.

UNIT-I	**Magnetic Field**	**Periods: 9**
Lorentz force, magnetic field intensity (H) – Biot–Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic force, Torque, Inductance, Energy density, Faraday's law - time varying field - B-H Relationship – Magnetically induced emf and force – AC operation of magnetic circuits – Hysteresis and Eddy current losses		**CO1**
UNIT-II	**DC Machines**	**Periods: 9**
Construction and principle of operation of DC Machine – Lap and wave winding – Excitation and types of generators – Circuit Model – Armature reaction – Compensating Winding – Commutation – Characteristics – Efficiency – Applications.		**CO1, CO2**
UNIT-III	**DC Motor**	**Periods: 9**
EMF and Torque – Circuit Model – Characteristics – Starting – Speed control – Efficiency – Testing direct, indirect and regenerative Tests – Braking - DC machines dynamics – Applications.		**CO2, CO3**
UNIT-IV	**Single phase Transformers**	**Periods: 9**
Review of Transformer operation, equivalent circuit – Construction – Phasor diagram –– Per Unit system – Losses – Efficiency and Voltage Regulation - All day efficiency – Parallel operation and load sharing of single phase transformers -Excitation phenomenon in Transformers – applications.		**CO1, CO4**
UNIT-V	**Polyphase Transformers and Special Transformers**	**Periods: 9**
Auto-transformer – Construction and saving in copper Testing – Applications - Three phase transformers – construction and connection - Phase Conversion – Tap changing – Variable frequency transformer		**CO5**

Lecture Periods: 30	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. Mathew N.O. Sadiku and S V Kulkarni, "Principles of Electromagnetic Fields", 6th Edition, Oxford University Press, 2015.
2. I.J. Nagrath and D.P. Kothari, Electric machines, T.M.H. Publishing Co.Ltd, New Delhi, 5th Edition, 2017.
3. B.L. Theraja, Electrical Technology - Vol.II, AC and DC Machines, S. Chand, 24th Edition, 2025.
4. S K Battacharya, Electrical Machines, Technical Teachers Training Institute, 4th Edition, 2017.
5. M.N. Bandyopadhyay, Electrical Machines - Theory and Practice, PHI, 2014

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	2	-	-	1	-	1	1	-	1	3
CO2	2	2	1	1	2	-	-	1	1	-	2	2	-	1	2
CO3	2	2	2	2	2	-	-	1	1	-	2	2	-	1	2
CO4	3	3	2	3	2	3	1	1	1	-	2	2	1	1	3
CO5	3	3	2	1	1	3	-	1	1	-	2	2	-	1	3

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Common to ALL**			Programme: **B.Tech.**						
Semester : **Third**			Course Category Code: **AEC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
HSUA103	**Entrepreneurship**		2	-	-	2	40	60	100
Prerequisite:									
Course Outcome: At the end of the course, the students will be able to	**CO1**	Understand entrepreneurial mindset, problem identification, customer segmentation, and value proposition development.							
	CO2	Develop and validate business models, test solutions, and create a Minimum Viable Product (MVP) through iterative feedback.							
	CO3	Analyze financial planning, revenue models, pricing strategies, and investor expectations for startup funding.							
	CO4	Apply sales, branding, digital marketing, automation, and teamwork strategies to successfully launch and scale a venture.							
UNIT-I	**Problem Identification and Customer Discovery**					**Periods: 6**			
Entrepreneurial mindset – Identifying business opportunities – Effectuation principles – Design Thinking for problem-solving – Consumer segmentation and customer persona – Value Proposition Canvas (VPC) – Unique Value Proposition (UVP) – Market research techniques – Emerging trends: AI in market research.									**CO1**
UNIT-II	**Business Model and Lean Startup**					**Periods: 6**			
Types of business models – Lean Canvas vs. Business Model Canvas – Competitor analysis – Blue Ocean Strategy – Building and testing Minimum Viable Product (MVP) – Build-Measure-Learn feedback loop – Digital Prototyping tools – Rapid Experimentation – Agile startup methodology.									**CO1, CO2**
UNIT-III	**Revenue Models, Costing, and Financial Planning**					**Periods: 6**			
Revenue models: Subscription, Freemium, and Pay-per-use – Unit economics: Cost structures and pricing strategies – Funding sources: Bootstrapping, Crowd-funding, Venture Capital – Investor expectations and funding rounds – Pitching to investors – Financial forecasting and break-even analysis – Government startup incentives.									**CO2, CO3**
UNIT-IV	**Digital Marketing and Sales Strategies**					**Periods: 6**			
Brand positioning and storytelling – Social media marketing and digital presence – SEO, SEM, and paid advertising – Data-driven marketing strategies – Sales funnels – Unique Sales Proposition (USP) – B2B vs. B2C sales – CRM tools for customer engagement – Customer retention strategies.									**CO3, CO4**
UNIT-V	**Team Building, Compliance, and Scaling**					**Periods: 6**			
Building and managing startup teams – Remote collaboration tools – Business registration and legal compliance – Intellectual Property Rights (IPR) for startups – Growth hacking and automation – Scaling strategies: Expansion and franchising – Emerging trends: AI in entrepreneurship, blockchain applications – Exit strategies: Mergers, acquisitions, IPOs.									**CO4**
Lecture Periods: 30	**Tutorial Periods: 0**		**Practical Periods: 0**				**Total Periods: 30**		

Reference Books:

1. **Eric Ries,** *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* by Crown Business, **1st Edition (2011)**.
2. **Alexander Osterwalder & Yves Pigneur,** *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, Wiley, **1st Edition (2010)**.
3. **Ash Maurya,** *Running Lean: Iterate from Plan A to a Plan That Works*, O'Reilly Media, **2nd Edition (2019)**.
4. **Steve Blank** and **Bob Dorf**, *The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company*, K&S Ranch, **1st Edition (2012)**.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	-	-	-	1	2	2	2	2	2
CO2	1	-	-	-	-	1	2	3	3	2	2
CO3	1	-	-	-	-	1	2	2	3	3	2
CO4	1	-	-	-	-	1	2	3	3	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Humanities and Social Sciences**		Programme: **B.Tech.**						
Semester : **Third**		Course Category Code: **VAC**				Semester Exam Type:		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
GEUC103	**Environmental Education**	1	-	-	1	100	-	100
Prerequisite:								

Course Outcome: At the end of the course, the students will be able to		
	CO1	Recall the concept of environment ecology and Education.
	CO2	Summarise the effect of population explosion, degradation of environment and global problem due to the anthropogenic activities.
	CO3	Justify the need of pollution control and sustainable development for future.

UNIT-I	**Introduction to Environmental Education**	**Periods: 5**
Concept, scope and importance of Environmental Education - Objectives of Environmental Education - Concept of an Ecosystem: Structure and functions, Types of ecosystem (aquatic and terrestrial) - Biodiversity: Levels, values, threats and conservation - Natural resources: Renewable and Non-renewable resources.		**CO1**
UNIT-II	**Environmental degradation and impact**	**Periods: 5**
Human population growth and its impact on environment - Deforestation: Causes and effects due to expansion of agriculture, firewood, mining and building of new habitats - Pollution: Definition, different types of Pollution - Air and water pollution: Causes and effect on environment - Climate change, Global warming, Ozone layer depletion and impacts on human communities.		**CO2**
UNIT-III	**Conservation of environment**	**Periods: 5**
Control measures for various types of Pollution: use of renewable and alternate source of energy - Environmental laws: Environmental Protection Act (1986), Water Act (1974), Air Act (1981) - International agreements: Montreal and Kyoto Protocol, Paris Agreement - Concept of sustainable development and SDGs - Role of government, NGOs and individual in environmental conservation.		**CO3**

Lecture Periods: 15	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 15**

Reference Books:

- Singh, J.S., Singh, S.P. and Gupta, S.R., 2014. "Ecology, Environmental Science and Conservation", S. Chand Publishing, New Delhi.
- Sharma, P. D., 2011. "Ecology and Environment", Rastogi Publications.
- Erach Bharucha, 2010. "Text Book of Environmental Studies", University Grants Commission, Universities Press (India) Pvt.Ltd., Hyderabad.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	-	-	-	3	1	-	-	-	1
CO2	1	-	-	-	-	3	1	-	-	-	1
CO3	-	-	-	-	1	3	2	1	-	-	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Third**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC107	**Electronic Devices and Circuits Laboratory**	-	-	3	1.5	40	60	100
Prerequisite:	Electron Devices and Circuits, Analog Electronics							
Course Outcome: At the end of the course, the students will be able to	**CO1**	Analyze the characteristics of semiconductor devices, including PN junction diodes, Zener diodes, BJTs, JFETs, SCRs, and UJTs, to understand their electrical behavior and applications.						
	CO2	Evaluate the performance of rectifiers, filters, and voltage regulators for DC power supply applications.						
	CO3	Design and test analog circuits, including amplifiers, oscillators, and multivibrators, for signal processing and waveform generation.						
	CO4	Implement and study wave-shaping and switching circuits, such as clippers, clampers, Schmitt triggers, and RC circuits, for pulse and signal conditioning applications.						
Any 10 Experiments								
1. V-I Characteristics of PN junction diode and voltage regulation characteristics of Zener diode. 2. Determination of ripple factor for half-wave and full-wave rectifiers with and without filter. 3. Clipper and Clamper circuits using diodes.								**CO1, CO2, CO4**
4. V-I Characteristics of Bipolar Junction Transistor (BJT) in Common-Base configuration. 5. V-I Characteristics of BJT in Common-Emitter configuration. 6. Biasing circuits for Transistor amplifiers (Fixed biasing and Voltage-divider biasing)								**CO1, CO3**
7. Drain and Transconductance characteristics of Junction Field Effect Transistor (JFET). 8. Triggering characteristics of Silicon-Controlled Rectifier (SCR). 9. Negative resistance characteristics of Uni-Junction Transistor and determination of intrinsic stand-off ratio.								**CO1**
10. Frequency response of transistor based single stage RC coupled amplifier. 11. Transistor based RC phase-shift oscillator. 12. Rectifier and Filter circuits 13. Regulator circuits								**CO2, CO3**
14. RC wave shaping circuits 15. Transistor based Astable and Monostable Multivibrator circuits 16. UJT relaxation oscillator 17. Schmitt trigger circuit								**CO3, CO4**
Lecture Periods: 0	**Tutorial Periods: 0**	**Practical Periods: 45**				**Total Periods: 45**		

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	2	-	1	3	3	2	1	-
CO2	3	3	3	3	-	-	2	-	1	3	3	2	1	-
CO3	3	3	3	3	-	-	2	-	1	3	3	2	1	-
CO4	3	3	3	3	-	-	2	-	1	3	3	2	1	-

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Third**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC108	**DC Machines and Transformers Laboratory**	-	-	3	1.5	40	60	100
Prerequisite:	DC Machines and Transformers							
Course Outcome: At the end of the course, the students will be able to	**CO1**	Get familiarized with the operation and the characteristics of different types of DC machine under loaded and unloaded conditions.						
	CO2	Get familiarized with the operation and the characteristics of different types of DC generators under loaded conditions.						
	CO3	Gain knowledge on various speed control measures of DC motors.						
	CO4	Understand the performance of single-phase and three phase transformers under no load and load conditions.						
	CO5	Gain knowledge about the parallel operation of single-phase transformer and 3 phase transformer connections.						

Any 10 experiments	
1. Performance determination of DC Motors by load test 2. Performance determination of DC shunt machine by Swinburne's (non-loading) test 3. Performance determination of DC machine by Hopkinson's (regenerative) test	**CO1, CO2**
4. Open circuit characteristics of self-excited DC shunt Generator 5. Performance determination of DC Generators by load test	**CO1, CO2**
6. Study of speed control of DC Motors 7. Study of Retardation test	**CO1, CO2, CO3**
8. Performance determination of single phase and three phase transformers by load test 9. Performance determination of single-phase transformer by non-loading (OC and SC) test 10. Performance determination of single-phase transformer by Back to Back (Sumpner's) test	**CO4, CO5**
11. Determination of Load sharing of single-phase transformers by Parallel operation 12. Study of three phase transformer connections	**CO5**

Lecture Periods: 0	**Tutorial Periods: 0**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

1. Laboratory Manual, Department of EEE, Puducherry Technological University, Puducherry

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	-	-	2	-	-	1	3	1	2
CO2	3	2	1	2	1	-	-	2	-	-	1	3	1	2
CO3	3	2	1	2	1	-	-	2	-	-	1	3	1	2
CO4	3	2	1	2	1	-	-	2	-	-	1	3	1	2
CO5	3	2	1	2	1	-	-	2	-	-	1	3	1	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Fourth**			Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC109	**Control Systems**		3	1	-	4	40	60	100
Prerequisite:	Transforms and Partial Differential Equations, Signals and Systems								
Course Outcome At the end of the course, the students will be able to	**CO1**	**Apply** the basic concepts of modelling of dynamical control systems in transfer function approach and to deduce the analogy between mechanical and electrical systems.							
	CO2	**Comprehend** the evolution of first order and second order dynamical systems when subjected to standard test signals during transient and steady state conditions.							
	CO3	**Evaluate** the locus of all possible closed-loop poles travel in s plane as a system parameter varies from 0 to ∞ and to compute the frequency response analysis of LTI systems using polar and Bode plots.							
	CO4	**Determine** the stability of dynamical systems using Routh-Hurwitz and Nyquist stability criteria and to compute the performance indices of a system in frequency domain.							
	CO5	**Develop** the modelling a dynamic system directly in time domain using state-space approach and to subsequently solve the state equation to assess the evolution of state variables with respect to time when subject to standard test signals.							
UNIT-I	**Introduction to Classical Control Theory**					**Periods: 12**			
Introduction to Control systems – Classical control theory concepts – linearity and time-invariance (LTI) properties – Physics based mathematical modeling of dynamical systems (mechanical and electrical systems) in transfer function approach – concept and significance of poles and zeros - Transfer Function frameworks: pole-zero form and time-constant form – Topologies: open and closed loop control systems – Analogous systems (Mechanical and Electrical Systems) – force-current and force-voltage analogy. Modelling of electro-mechanical systems (DC servo systems with armature and field control topologies). Simplification of interconnected systems using block diagram reduction technique and S. J. Mason's gain formula (signal flow graphs).								**CO1**
UNIT-II	**Time-Response Analysis of Linear Dynamical Systems**					**Periods: 12**			
Standard test signals–Transient response analysis of first and second order systems using standard test signals (step, impulse and ramp) –correlation between pole location in s-plane and time-response– transient response specification for second-order systems. Steady state response analysis– error constants for Type 0, 1 and 2 systems. Error Criteria – IAE, ISE, ITAE and ITSE criteria. Dependence of error criteria on system parameters for second order systems.									**CO1, CO2**
UNIT-III	**Root Locus Plots and Frequency Response Analysis**					**Periods: 12**			
Concept of Root – construction of root locus – concept of root contours for multiple parameter variations. Frequency response analysis: Sinusoidal transfer function - Frequency response and its importance – correlation between frequency response and time-response analysis for second order systems and frequency response specifications. Frequency response plots – Polar plot, Bode plot and log-magnitude versus phase plot. All pass and minimum phase systems.									**CO2, CO3**
UNIT-IV	**Stability of Dynamic Systems**					**Periods: 12**			
Concept of BIBO stability and Internal Stability of LTI systems (impulse response analysis) – Routh and Hurwitz stability criteria – relative stability analysis using Routh's stability criterion. Stability analysis in frequency domain – Nyquist stability criterion – Relative stability analysis of dynamic systems using phase margin and gain margin specifications – Closed-loop frequency response – constant M and N circles – Nichols chart (qualitative treatment only).									**CO2, CO4**
UNIT-V	**Modern Control Theory - State Space Analysis of Dynamical Systems**					**Periods: 12**			
Modelling of physical systems using state-space approach – advantages of state-space approach over transfer function approach. State-space model using physical variable approach for SISO and MIMO systems – State-space modelling using phase variable and canonical variable approaches for SISO systems. Derivation of transfer function from state-space model for LTI systems.									**CO1, CO5**

Solution to state equation–homogenous system and forced system– state transition matrix and its properties – ascertaining stability from eigen values of the system matrix. Introduction to controllability and observability.

Lecture Periods: 45	Tutorial Periods: 15	Practical Periods: 0	Total Periods: 60

Reference Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall, 2010.
2. I J Nagrath and M. Gopal, "Control Systems Engineering", New Age International (P) Limited, 2008.
3. Norman S Nise, "Control Systems Engineering", 7th Edition, Wiley, 2015.
4. Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", 8th Edition, Pearson, 2018.
5. Joseph J. Distefano, III, Allen R. Stubberud and Ivan J. Williams, 'Feedback and Control Systems", Schaum's Outlines, Second Edition, Tata-McGraw Hill Edition, 2003.
6. Raymod T. Stefani, Bahram Shahian, Clement J. Savant, Jr. and Gene H. Hostetter, "Design of Feedback Control Systems", Oxford University Press, 2004.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	-	-	-	-	-	-	3	2	1
CO2	3	3	1	2	2	-	-	-	-	-	-	3	2	1
CO3	3	2	2	2	2	-	-	-	-	-	-	3	2	1
CO4	2	3	2	2	1	-	-	-	-	-	1	3	2	1
CO5	3	3	1	2	1	-	-	-	-	-	-	3	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fourth**		Course Category Code: **PCC**			Semester Exam Type: **TY**			
Course code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC110	**Digital Electronics**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome At the end of the course, the students will be able to		
	CO1	**Understand number systems, codes, and Boolean algebra** to perform arithmetic operations, logic simplifications, and digital circuit design.
	CO2	**Analyze and compare different logic families** and their characteristics to design and implement combinational logic circuits like adders, multiplexers, and encoders.
	CO3	**Design and implement sequential logic circuits**, including flip-flops, counters, and shift registers, for digital system applications.
	CO4	**Develop synchronous and asynchronous sequential circuits** using state transition diagrams, state reduction techniques, and circuit design equations.
	CO5	**Explore semiconductor memories and programmable logic devices (PLDs)** such as ROM, PLA, and PAL for memory decoding and digital system design.

UNIT-I	**Number systems and Boolean algebra**	**Periods: 9**
Number system and codes: Binary, octal, hexadecimal and decimal Number systems and their inter conversion, BCD numbers, Gray code, excess–3 code, cyclic code, code conversion, ASCII, EBCDIC codes. Binary addition and subtraction, signed and unsigned binary numbers, 1's and 2's complement representation. Boolean Algebra: Basic logic circuits: Logic gates, Universal Gates, Laws of Boolean algebra, De-Morgan's theorem, Simplification by boolean theorems, Min term, Max term, POS, SOP, Karnaugh Map, don't care condition		**CO1, CO5**

UNIT-II	**Logic families and Combinational logic circuits**	**Periods: 9**
Logic Families: Introduction to digital logic family such as RTL, DTL, TTL, ECL, CMOS, IIL, HTL etc., their comparative study, basic circuit, performance characteristics, Wired logic, open collector output etc Combinational Logic: Half adder, full adder, subtractor circuits. Magnitude comparator, Multiplexer and demultiplexer, decoder, BCD to seven segment Decoder, encoders.		**CO1, CO2**

UNIT-III	**Sequential logic circuits**	**Periods: 9**
Set-Reset laches, D-flip-flop, R-S flip-flop, J-K Flip-flop, Master slave Flip flop, edge triggered flip-flop, T flip-flop. Design of counters using Flip-flops– Synchronous, asynchronous, Up/Down counters, decade counter, ring counter, Johnson counter, BCD counter–Shift registers - Parallel/serial and bi-directional shift registers.		**CO2, CO3**

UNIT-IV	**Design of Sequential Circuits**	**Periods: 9**
Design of Synchronous sequential circuits: Model Selection– State transition diagram – state synthesis table – Design equations and circuit diagram– State reduction technique. Asynchronous sequential circuits – Analysis – Problems with asynchronous sequential circuits – Design of asynchronous sequential circuits State transition diagram, Primitive table, State reduction, state assignment and design equations.		**CO3, CO4**

UNIT-V	**Semiconductor Memories and Programmable logic devices**	**Periods: 9**
Introduction – Random Access Memory – Memory decoding – Error detection and correction - Charge coupled device (CCD)–Introduction to Programmable logic devices(PLD)-Read-Only Memory, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), Sequential programmable devices.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. M Morris Mano, Michael D. Ciletti, Digital Design, 6th Edition, Pearson, 2018
2. D.P. Leach, A. P. Malvino and Goutam Saha, Digital Principles and Applications, 8th Edition, McGraw Hill Education, 2014
3. Thomas L Floyd, Digital Fundamentals, Pearson Education, 2018

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	-	1	2	-	-
CO2	3	2	2	-	-	-	-	-	-	-	1	2	-	1
CO3	3	2	2	-	-	-	-	-	-	-	1	2	-	1
CO4	3	2	2	-	-	-	-	-	-	-	1	2	-	1
CO5	3	1	-	-	-	-	-	-	-	-	1	2	-	1

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fourth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC111	**AC Machines**	2	1	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to	**CO1**	Provide knowledge on three phase induction motor, construction and operation and its equivalent circuit and performance characteristics.
	CO2	Provide knowledge on starting and speed control methods for induction motor and types of induction generator.
	CO3	Familiarize construction and operation of synchronous generator, EMF equation and voltage regulation.
	CO4	Understand the operation of synchronous motor, its phasor diagram and its characteristics.
	CO5	Introduce recent trends in special machines, its characteristics, reluctance motor, stepper motor and servo motor.

UNIT-I	**Three Phase Induction Motor:**	**Periods: 9**
AC windings – MMF of distributed winding - Rotating magnetic field - Construction, types and operation of 3-ph induction motors – Equivalent circuit – Torque-Power relationships – Performance characteristics - Effect of supply voltage and rotor resistance on torque – Load test, No load and Blocked rotor test.		**CO1**
UNIT-II	**Induction Motor Starting and Speed Control:**	**Periods: 9**
Starting methods– braking-Cogging and crawling – Speed control methods and influence on speed-torque curve– Double cage rotor – Induction generator – types – Induction machine dynamics – Synchronous induction Motor		**CO1, CO2**
UNIT-III	**Synchronous Generator:**	**Periods: 9**
Types, construction and principle of operation – EMF equation – armature reaction – Voltage regulation by synchronous impedance, MMF and Potier triangle methods - Load characteristics –Synchronizing to infinite bus-bars – Power transfer equations, capability curve – Two reaction model of salient pole synchronous machines and power angle characteristics - Determination of Xd & Xq by slip test.		**CO1, CO3, CO4**
UNIT-IV	**Synchronous Motor:**	**Periods: 9**
Principle of operation – Power flow – phasor diagrams – Torque angle characteristics – Effect of varying load and Excitation – Excitation and power circles for synchronous machine – 'V' and inverted 'V' curves – hunting – Synchronous phase modifier – Induction motor Vs Synchronous motor.		**CO3, CO4**
UNIT-V	**Single Phase and Special Machines:**	**Periods: 9**
Single phase induction motors – Rotating magnetic Vs alternating magnetic field - Double revolving field theory – Torque - speed characteristics – Types of induction motor – Reluctance motor– Two phase Servo motor– Stepper motors – Universal motor- linear induction motor - permanent magnet DC motor.		**CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. I.J. Nagrath and D.P. Kothari, Electric machines, T.M.H. Publishing Co.Ltd, New Delhi, 5th Edition, 2017.
2. B.L. Theraja, Electrical Technology - Vol.II AC and DC Machines, S. Chand, 24th Edition, 2025.
3. Battacharya S K, Electrical Machines, Technical Teachers Training Institute, 4th Edition, 2017.
4. P.C. Sen, Principles of Electric Machines and Power Electronics, Wiley Student Edition, 2nd Edition,2008.
5. M.N. Bandyopadhyay, Electrical Machines - Theory and Practice, PHI, 2014

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	-	1	1	-	1	2	1	2
CO2	3	3	1	2	1	3	-	1	1	-	1	2	1	2
CO3	3	3	2	3	1	2	-	1	1	-	1	2	1	2
CO4	3	3	1	2	1	3	-	1	1	-	-	2	1	2
CO5	3	2	2	1	-	3	-	1	1	-	2	2		1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Computer Science and Engineering**			Programme: **B.Tech.** (MTE/ECE/EEE/EIE)						
Semester: **Fourth**			Course Category Code: **PCC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CSUC137	**Data Structures and Object – Oriented Programming**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	Apply the fundamental concepts of data structures in software applications.							
	CO2	Implement linear data structures in online marketing.							
	CO3	Design algorithms for non-linear data structures applied in Banking sectors.							
	CO4	Apply sorting, searching algorithms and Hashing methods in Database Management System.							
	CO5	Develop reusable and maintainable software components using OOP principles.							
	CO6	Implement file handling techniques in C++ to perform input and output operations with external files using data structures and object-oriented methodologies.							
UNIT-I	**Lists, Stacks and Queues**					**Periods: 09**			
Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists – Polynomial ADT – Radix Sort – Multilists – Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressions – Infix to Postfix conversion – Function Calls – Queue ADT – Operations – Circular Queue – DeQueue – Applications of Queues.									**CO1, CO2, CO6**
UNIT-II	**Trees and Graphs**					**Periods: 09**			
Tree ADT – Tree Traversals - Binary Tree ADT – Expression trees – Binary Search Tree ADT – AVL Trees – Priority Queue (Heaps) – Binary Heap – B-Tree – B+ Tree – Graph Definition – Representation of Graphs – Types of Graph - Breadth-first traversal – Depth-first traversal –– Bi-connectivity – Euler circuits – Topological Sort – Dijkstra's algorithm – Minimum Spanning Tree – Prim's algorithm – Kruskal's algorithm									**CO1, CO3, CO6**
UNIT-III	**Searching, Sorting and Hashing Techniques**					**Periods: 09**			
Searching – Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort – Merge Sort – Hashing – Hash Functions – Separate Chaining – Open Addressing –Rehashing – Extendible Hashing.									**CO1, CO4, CO6**
UNIT-IV	**Introduction to Object-Oriented Programming and C++ Basics**					**Periods: 09**			
Understanding core OOP concepts: Classes and Objects – Encapsulation and Data Hiding – Abstraction – Inheritance – Polymorphism –Basics of C++ programming: Syntax and Structure – Data Types and Operators – Control Structures (if-else, loops) – Functions and Parameter Passing – Procedural and Object-Oriented Programming – Classes and Objects in C++ – Defining and Implementing Classes – Access Specifiers: public, private, protected – Member Functions and Data Members – Constructors and Destructors: Default Constructors – Parameterized Constructors – Copy Constructors – 'this' Pointer – Static Members.									**CO5, CO6**
UNIT-V	**Inheritance, Polymorphism and Advanced Features in C++**					**Periods:09**			
Inheritance: Base and Derived Classes – Types of Inheritance: Single, Multiple, Multilevel, Hierarchical, Hybrid – Constructor and Destructor Behavior in Inheritance – Polymorphism: Compile-Time Polymorphism: Function and Operator Overloading – Run-Time Polymorphism: Virtual Functions and Abstract Classes – Pointers to Objects and Virtual Functions – Templates: Function Templates – Class Templates – Exception Handling: try, catch, throw Mechanism – Standard Exceptions – File Handling: File Streams (ifstream, ofstream, fstream) – Reading from and Writing to Files – File Modes and Error Handling – Standard Template Library (STL): Containers, Iterators, Algorithms.									**CO5, CO6**
Lecture Periods: 45	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 45**			

Reference Books:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2005.
2. Kamthane, Introduction to Data Structures in C, 1st Edition, Pearson Education, 2007.
3. Object Oriented Programming with C++ by E. Balagurusamy, McGraw-Hill Education (India).
4. ANSI and Turbo C++ by Ashoke N. Kamthane, Pearson Education.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	-	-	1	-	-	3
CO2	3	2	3	2	2	-	-	-	-	-	1	-	-	3
CO3	3	3	3	3	2	-	-	-	-	-	2	-	-	3
CO4	3	3	3	2	2	-	-	-	-	-	2	-	-	3
CO5	3	2	3	2	2	-	-	-	-	-	1	-	-	3

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fourth**		Course Category Code: **AEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
HSUA104	**Design Thinking**	2	-	-	2	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to		
	CO1	Apply Design Thinking to solve engineering problems
	CO2	Generate creative solutions for real-world problems using brainstorming and other idea-generation techniques
	CO3	Build and test prototypes to validate design ideas and improve them based on user feedback.
	CO4	Work in teams and communicate ideas effectively through presentations, reports, and discussions.

UNIT-I	**Introduction to Design Thinking**	**Periods: 6**
Understanding the Need for Design Thinking in Engineering - Five-Stage Process: Empathize, Define, Ideate, Prototype, Test - Case Studies: How Engineering Innovations Used Design Thinking - Mindset Shift: From Problem-Solving to Human-Centered Design **Team Exercise:** Identify a real-world engineering problem and discuss how Design Thinking can be applied.		**CO1, CO4**
UNIT-II	**Empathize**	**Periods: 6**
Importance of User Research in Engineering Solutions - Techniques: Interviews, Observations, Surveys, Empathy Mapping - Engineering Constraints vs. User-Centric Needs - Role of Emotional Intelligence in Product Development **Team Exercise:** Conduct field research (interview users or observe a process) and create an Empathy Map for an engineering challenge.		**CO1, CO2**
UNIT-III	**Define & Ideate**	**Periods: 6**
Problem Definition Techniques: How to Frame the Right Problem - Creating Point of View (POV) Statements - Brainstorming & Idea Generation Techniques: SCAMPER, Reverse Thinking, Mind Mapping - Evaluating and Selecting Feasible Engineering Solutions **Team Exercise:** Define a problem statement and conduct a Brainstorming Workshop to generate innovative solutions.		**CO2, CO4**
UNIT-IV	**Prototyping**	**Periods: 6**
Importance of Rapid Prototyping in Engineering - Types of Prototypes: Paper, Digital, Physical Models, Simulation - Tools & Technologies: 3D Printing, CAD, Arduino, Low-Code Development - Iteration & Refinement – Learning from Failures **Team Exercise**: Develop a low-fidelity prototype of an engineering solution and present it to peers for feedback.		**CO3, CO4**
UNIT-V	**Testing, Iteration & Implementation**	**Periods: 6**
Methods of Testing: Usability Testing, A/B Testing, Stress Testing - Gathering Feedback: Stakeholder & User Insights - Iteration Strategies: Continuous Improvement & Agile Thinking - Real-World Engineering Applications of Design Thinking **Team Exercise:** Conduct a user test on the prototype, refine it based on feedback, and present the final solution in a showcase session.		**CO3, CO4**

Lecture Periods: 30	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 30**

Reference Books:

1. Michael Lewrick, Patrick Link, and Larry Leifer, *The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods*, Wiley, 1st Edition, 2020.
2. Teun den Dekker, *Design Thinking*, Noordhoff Uitgevers bv,International Edition, 2020
3. Angèle M. Beausoleil, *Business Design Thinking and Doing*, Palgrave Macmillan Imprint, Springer, 2022
4. Soni Pavan, *Design your Thinking*, Penguin Random House India Publishing, 2020
5. E Balagurusamy, *Design Thinking*, McGraw Hill; First Edition, 2024

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	2	1	2	1	2	3
CO2	3	3	3	2	2	2	-	2	3	2	3
CO3	3	2	3	3	3	2	1	3	2	3	3
CO4	-	-	3	2	-	2	3	3	3	3	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Humanities and Social Sciences**			Programme: **B.Tech.**						
Semester : **Fourth**			Course Category Code: **AEC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
HSUA106	**Foreign Language - FRENCH**		2	-	-	2	40	60	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	Acquire the basics of the French language							
	CO2	Apply the acquired basics of the language in expressing oneself							
	CO3	Develop basic conversation skills							
	CO4	Communicate their student life in the University context							
	CO5	Equip the students to communicate within technical contexts							
UNIT-I	**INTRODUCTION TO FRENCH AND BASICS**					**Periods: 6**			
French alphabets and pronunciation – Greetings and Introductions (Bonjour ça va?) – Numbers, days of the week, months, seasons – Classroom expressions and instructions – Articles (Definite and Indefinite) – Basic sentence structure (Subject – Verb Agreement)									**CO 1**
UNIT-II	**PERSONAL IDENTITY AND EXPRESSIONS**					**Periods: 6**			
Introducing oneself and others (Je me présente……) – Nationalities and Professions – Describing people (Physical appearance and Personality) – Possessive adjectives (mon, ma, mes…) – Gender and number agreement of adjective.									**CO 2**
UNIT-III	**DAILY LIFE AND ROUTINES**					**Periods: 6**			
Talking about daily activities and schedules (Je me lève à 7 heures…) – Telling the time and discussing time tables – Common verbs in the present tense (ER, IR, RE verbs) – Reflexive verbs (Se lever, s'habiller…)									**CO 3**
UNIT-IV	**DIRECTIONS AND UNIVERSITY LIFE**					**Periods: 6**			
Asking for and giving directions (Où est….? A gauche, A droite…) – Describing locations (Près de, loin de….)- Talking about University courses and subjects (J'éudie l'ingénierie…) - Prepositions of place (sur, sous, devant….) – Using Il y a and C'est for descriptions									**CO 4**
UNIT-V	**FUTURE PLANS, BASIC TECHNICAL PRESENTATIONS AND TECHNICAL AND ENGINEERING CONTEXTS**					**Periods: 6**			
Talking about future career goals (Je veux devenir ingénieur…..) Using future proche for near future plans- Vocabulary related to Engineering disciplines – Talking about machines and materials (Acier, moteur, circuit….) – Giving simple presentations on technical topics – Introduction to passive voice (La machine est réparée….)									**CO 5**
Lecture Periods: 30	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 30**			

Reference Books:

1. Nouvelle Generations A1, Luca Giachino, Carla Baracoo, Didier FLE, 2020, Paris
2. Tech French – French for Science and Technology, Ingrid Le Gargasson, Shariva Naik et Claire Chaize, Goyal Publishers, 1 April 2011.
3. Écho – Méthode de Français, A1 , Girardet, Pecheur, CLE International,2013.
4. Écho Cahier personnel d'apprentissage, A1, Girardet, Pecheur, CLE International, 2013.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	-	-	3	3	-	3
CO2	-	-	-	-	-	-	-	3	3	-	3
CO3	-	-	-	-	-	-	-	3	3	-	3
CO4	-	-	-	-	-	-	-	3	3	-	3
CO5	-	-	-	-	-	-	-	3	3	-	3

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Common to all**			Programme: **B.Tech.**						
Semester : **Fourth**			Course Category Code: **VAC**				Semester Exam Type:		
Course Code	Course Name:		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
GEUC104	**Universal Human Values**		1	-	-	1	100	-	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	**Develop a Holistic Understanding of Value Education**							
	CO2	**Foster Personal and Social Harmony**							
	CO3	**Enhance Awareness of Universal Co-existence**							
	CO4	**Apply Ethical and Humanistic Principles in Professional and Personal Life**							

Module--**I**	**Introduction to Value Education**	**Periods: 3**
Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations		**CO1**
Module-**II**	**Harmony in the Human Being**	**Periods: 3**
Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health		**CO2**
Module-**III**	**Harmony in the Family and Society**	**Periods: 3**
Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-toHuman Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order		**CO2**
Module-**IV**	**Harmony in the Nature/Existence**	**Periods: 3**
Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence		**CO3**
Module-**V**	**Implications of the Holistic Understanding**	**Periods: 3**
A Look at Professional Ethics : (3 hours) Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession		**CO4**

Lecture Periods: 15	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 15**

Reference Books:

1. Student Induction Program Handbook v2 by AICTE NCC-IP sub-committee: Dr. Rajneesh Arora, Chairman NCC-IP, Dr. Shishir Gaur, Convener NCC-IP, Dr. Ruchir Gupta, Member NCC-IP.
2. R R Gaur R Asthana G P Bagaria, A foundation course in HUMAN VALUES and professional ethics, Understanding Human Being, Nature and Existence Comprehensively By UHV Team (https://uhv.org.in/uhve)
3. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics RR Gaur, R Asthana, GP Bagaria

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						3	3	2	2	2	3
CO2						3	3	3	3	2	3
CO3						3	3	2	2	2	3
CO4						3	3	2	2	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Fourth**			Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC112	**Digital Electronics Laboratory**		-	-	3	1.5	40	60	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	Verify the working of logic gates							
	CO2	Design and test combinational logic circuits							
	CO3	Construct and test different flip-flops using logic gates							
	CO4	Construct and test different sequential logic circuits							

Any 10 experiments:

1. Study of logic gates, verification of De-Morgan's laws and realization of basic gates using universal gates. 2. Combinational logic circuits – full and half Adder/Subtractor, arbitrary combinational logic circuit. 3. 4-bit adder/subtractor & BCD adder using IC 7483 4. Encoder and decoder using logic gates. 5. Multiplexer and de-multiplexer using logic gates. 6. Code converters (BCD-to-GRAY, BCD-to-Excess 3 and vice versa) using logic gates. 7. Magnitude Comparator 8. Sequence generator	**CO1** **CO2**
9. Realization of R-S, D, J-K and T flip-flops using logic gates. 10. Sequential logic circuits: Up/Down counters/MOD-10 counters using IC 7476 (J-K Mater-Slave Flipflop). 11. Ring counter and Johnson counter using IC7476. 12. Decade counter using IC7490	**CO3** **CO4**

Lecture Periods: 0	**Tutorial Periods: 0**	**Practical Periods:45**	**Total Periods: 45**

Reference Books:

1. Laboratory Manual, Department of EEE, Puducherry Technological University, Puducherry.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	2	-	-	-	2		1
CO2	3	3	2	3	2	-	-	2	-	-	-	2		1
CO3	3	2	1	1	1	-	-	2	-	-	-	2		1
CO4	3	3	2	3	2	-	-	2	-	-	2	2		1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fourth**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC113	**AC Machines Laboratory**	-	-	3	1.5	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to		
	CO1	Understand the operation, performance and the characteristics of different types of Induction machines under loaded and unloaded conditions.
	CO2	Get familiarized with various speed control measures of Induction motors.
	CO3	Gain knowledge about the parallel operation of Alternator and Induction Generator with bus bars.
	CO4	Realize the operation, performance and the characteristics of Alternators.
	CO5	Realize the operation, performance and the characteristics of Synchronous motor and universal motor.

Any 10 experiments	
1. Performance determination of 3-phase squirrel cage Induction Motor by load test 2. Performance determination of 3-phase slip ring Induction Motor by load test 3. Performance determination of 3-phase squirrel cage Induction Motor by non-loading (No load and Blocked Rotor) tests using equivalent circuit and circle diagram 4. Performance determination of single-phase Induction Motor by load test	**CO1, CO2**
5. Study of starters and speed control of Induction Motor	**CO1, CO2**
6. Synchronization of three phase Alternator with bus bars 7. Performance determination of 3-phase Induction Generator under grid connected mode	**CO2, CO3**
8. Performance determination of 1-phase Alternator by load test 9. Performance determination of 3-phase Alternator by load test 10. Performance determination of 3-phase Alternator by non-loading (OC & SC) tests by EMF, MMF & Potier Triangle methods 11. Determination of direct axis reactance and quadrature axis reactance of a salient pole alternator by slip test.	**CO4, CO4**
12. Performance characteristics of an auto synchronous motor 13. Performance characteristics of Universal Motor	**CO5**

Lecture Periods: 0	**Tutorial Periods: 0**	**Practical Periods: - 45**	**Total Periods: 45**

Reference Books:

1. Laboratory Manual, Department of EEE, Puducherry Technological University, Puducherry

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	-	-	1	`	1	1	2	-	3	1	2
CO2	2	2	1	-	-	1	`	1	1	2	-	3	1	2
CO3	2	2	1	-	-	1	`	1	1	2	-	3	1	2
CO4	2	2	1	-	-	1	`	1	1	2	-	3	1	2
CO5	1	2	1	-	-	1	`	1	1	2	-	3	1	2

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Computer Science and Engineering**		Programme: **B.Tech.**						
Semester: **Fourth**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CSUC138	**Data Structures and Object – Oriented Programming Laboratory**	-	-	3	1.5	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to		
	CO1	Develop proficiency in coding linear data structures such as arrays, linked lists, stacks, queues and enhance their ability to manage the data efficiently.
	CO2	Design and implement non-linear data structures like trees and graphs, also enable them to handle complex data relationships and hierarchies.
	CO3	Apply various sorting and searching algorithms in real-time applications of web search engines, social media platforms and file systems.
	CO4	Apply OOP principles of classes, objects, inheritance, polymorphism, and encapsulation to create modular and reusable code.
	CO5	Apply data structures and OOP Concepts to manage data storage and retrieve them using file operations.
	CO6	Integrate data structures and OOP to design comprehensive software solutions.

Ex. No.	**Experiment Name/Brief Description**	
1. 2. 3. 4. 5.	Write a program to implement Stack, Queue, and Circular Queue using arrays. Develop a program for creating and performing operations on Singly Linked List. Implement Stack and Queue ADTs using Linked List. Write a program for Polynomial addition and multiplication using Linked List. Convert an Infix expression to Postfix and evaluate the Postfix expression.	**CO1, CO6**
6. 7. 8. 9. 10.	Design a Binary Search Tree and perform insertion, deletion, and traversal operations. Implement AVL Tree with rotations for balancing. Develop a Priority Queue using Heap data structure. Write a C program to find the shortest path using Dijkstra's Algorithm. Construct Minimum Spanning Tree using Prim's Algorithm.	**CO1, CO2, CO6**
11. 12. 13. 14.	Implement Linear Search and Binary Search for an array. Sort the given array using Insertion Sort and Selection Sort. Write a program to perform Merge Sort using recursion. Implement Hashing using Open Addressing techniques like Linear Probing and Quadratic Probing.	**CO1, CO3, CO6**
11. 12. 13. 14. 15. 16.	Write a program Illustrating Class Declarations, Definition, and Accessing Class Members. Program to illustrate default constructor, parameterized constructor and copy constructors. Write a C++ program to implement the matrix ADT using a class. The operations supported by this ADT are: a) Reading a matrix. b) Addition of matrices. c) Printing a matrix. d) Subtraction of matrices. e) Multiplication of matrices. Write C++ programs that illustrate how the following forms of inheritance are supported: a) Single inheritance b) Multiple inheritance c) Multi level inheritance d) Hierarchical inheritance. Write a C++ Program Containing a Possible Exception. Use a Try Block to Throw it and a Catch Block to Handle it Properly. Write a Program to Demonstrate the Catching of All Exceptions.	**CO4, CO6**
17. 18.	A) Create a function template for sorting arrays of various data types. B) Develop a class template for a stack that can handle different data types. A) Utilize STL containers like vector, list, and map to manage collections of data. B) Implement algorithms such as find, sort, and accumulate using ST.	**CO5, CO6**

Lecture Periods: 0	**Tutorial Periods: 0**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

1. Fundamentals of Data structures in C, 2nd Edition, E.Horowitz, S.Sahni and Susan Anderson Freed, Universities Press.
2. Data structures A Programming Approach with C, D.S.Kushwaha and A.K.Misra, PHI.
3. Object Oriented Programming with C++ by Balagurusamy
4. C++, the Complete Reference, 4th Edition, Herbert Schildt, TMH.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	-	2	-	-	-	-	-	-	-	-	3
CO2	3	3	3	-	2	-	-	-	-	-	-	-	-	3
CO3	3	3	3	-	2	-	-	-	-	-	-	-	-	3
CO4	3	2	3	-	2	-	-	-	-	-	-	-	-	3
CO5	3	2	3	-	2	-	-	-	-	-	-	-	-	3
CO6	3	3	3	-	2	-	-	-	-	-	-	-	-	3

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester: **Fourth**		Course Category Code: **HNC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUH101	**Network Analysis and Synthesis**	3	1	-	4	40	60	100
Prerequisite:	Transforms and Partial Differential Equations							

Course Outcome: At the end of the course students will be able to		
	CO1	**Develop Laplace-transformed networks for steady-state and transient analysis.**
	CO2	**Understand Laplace and Fourier transforms and apply Thevenin's and Norton's theorems for circuit transformation.**
	CO3	**Explore electrical network parameters for various applications.**
	CO4	**Analyse** network functions, poles and zeros, two-port parameters and physical reliability of electrical networks.
	CO5	**Synthesize** reactive one-port networks using Foster's and Cauer methods and design various filters

UNIT-I	**Networks and Laplace Transform I**	**Periods: 12**
Network equation, Formulation of network equations, Initial conditions in networks and network solution with Laplace transformation, Step, Ramp and Impulse functions, Initial and Final value theorem and Convolution Integral.		**CO1**
UNIT-II	**Networks and Laplace Transform II**	**Periods: 12**
Transform impedance and transform circuits, Thevenin's and Norton's theorem, Duality, Fourier transform, Discrete and Continuous spectrum, relation and Laplace transforms.		**CO1 CO2**
UNIT-III	**Modelling of Two port Network and Application**	**Periods: 12**
Image parameter description of a reciprocal two-port network -- Image impedance - Characteristic impedance - propagation constant—derivation of characteristic impedance and propagation constant for T and π networks under sinusoidal steady state - Attenuation constant and phase constant.		**CO1, CO3**
UNIT-IV	**Network Functions**	**Periods: 12**
Calculation of network function for ladder and general networks, poles and zeros with restrictions for driving point functions and transform functions, two-port parameters Hurwitz polynomials –properties - Positive real functions –Properties of positive real functions – passivity-necessary and sufficient conditions for positive real functions-physical reliability.		**CO4**
UNIT-V	**Synthesis of One Port Network and Filters**	**Periods: 12**
Synthesis of reactive one-ports by Foster's and Cauer methods (Forms I and II) - Synthesis of LC, RC and RL driving-point functions. Low pass filter, high pass filter, band pass filter, band reject filter, Gain equalizer and delay equalizer, Butterworth filter, m-derived filter, constant k-filter, Design of filters.		**CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. "Network Analysis" by M.E. Van Valkenburg: 3rd Edition Prentice Hall India.
2. "Network Analysis and Synthesis" by Ravish R. Singh: 2nd Edition 2019: McGraw-Hill Education.
3. "Network Analysis and Synthesis" by Franklin F. Kuo: 2nd Edition: Wiley India.
4. "Electric Circuit Analysis" by K.S. Suresh Kumar: 2013 Edition Pearson Publications
5. "Network Analysis and Synthesis" by S.P. Ghosh and A.K. Chakraborty: 2009 Edition: Tata McGraw Hill
6. "Circuits and Networks" by A. Sudhakar and Shyammohan S. Palli: 3rd Edition: Tata McGraw Hill 2006.
7. "Network Analysis and Synthesis" by C.L. Wadhwa: 5th Edition: Published by New Age Publications.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	-	1	-	1	2	1	-
CO2	3	3	3	1	1	-	-	-	2	-	1	2	1	-
CO3	3	3	3	2	1	-	-	-	2	-	1	2	1	-
CO4	3	3	3	2	1	-	-	-	2	-	1	2	1	-
CO5	3	3	2	2	1	-	-	-	2	-	1	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC114	**Power Electronics**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to	**CO1**	Understand the features of different power semiconductor devices and select them for different power electronic circuits and applications
	CO2	Analyse the working of power electronics circuits with waveforms and mode diagrams
	CO3	Appraise the influence of load types on the converter performance
	CO4	Recognise and conclude the influence of switching strategies on performance of converters

UNIT-I	**Power Semiconductor Devices**	**Periods: 9**
Power Semiconductor Devices (PSDs) Overview – Characteristics of an ideal switch, types, symbols, switching and control characteristics, ratings of PSDs. SCR, MOSFET and IGBT- Construction, Structural difference from signal devices. Static and dynamic characteristics. Static and dynamic characteristics of PSDs - SCR, MOSFET and IGBT. SCR- Two transistor model, Turn-on - turn-off methods, Protection and Snubber design, R, RC and UJT firing circuits. Introduction to Power Modulators.		**CO1**
UNIT-II	**Phase Controlled Rectifiers**	**Periods: 9**
Understanding Principles of Phase Controlled Rectification through Single-Phase Half Wave PCR-Phase angle control, Pulse number, Influence of nature of load and free-wheeling diode on load current, Quadrants of working. Single and Three Phase Semi and Fully Controlled Rectifiers – Power circuit, waveforms, mode diagrams and output voltage relations for continuous (with ripple and without ripple) and discontinuous load currents; Working of Dual converters; Numerical Problems. Effect of Source Inductances in Single and Three Phase Fully Controlled Rectifiers.		**CO1, CO2, CO3**
UNIT-III	**DC Choppers**	**Periods: 9**
Principles of Chopper- Frequency modulation, PWM; Types based on input-output voltage and quadrants; Buck, Boost and Buck- Boost Choppers-Working, Waveforms, Output voltage Relations; Class A, B, C, D & E Choppers- Quadrants of working, waveforms; Voltage Commutated and Current Commutated Choppers-Working, Waveforms, mode diagrams; Numerical Problems.		**CO1, CO2, CO4**
UNIT-IV	**Inverters**	**Periods: 9**
Single Phase H Bridge VSI- Square wave operation, Harmonic analysis, Necessity of PWM; Single pulse modulation, Multiple pulse modulation, SPWM, SHEPWM- Voltage control and Harmonic spectrum. SCR based VSI- Series inverter and Parallel inverter; Single-phase CSI-Capacitor commutated and Auto Sequential Commutated. Three Phase VSI- Six step operation in 180^0 and 120^0 conduction modes using fundamental switching; Three Phase Natural Sampled PWM Strategies.		**CO1, CO2, CO4**
UNIT-V	**AC Choppers and Cycloconverters**	**Periods: 9**
Single Phase AC Voltage Controller- Integral cycle and Phase angle control, Single phase AC Voltage controller – Working, waveforms and output voltage for continuous and discontinuous load currents; Gate pulses for RL loads; Numerical Problems. Different Configurations of Three Phase AC Voltage Controller-Comparison; Working of three wire voltage controller with resistive star load. Bridge Type Single Phase to Single Phase and Three Phase to Single Phase Cycloconverters- Operation for frequency ratios 1:3 and 1:5, Waveforms, Output voltage expression, Switching strategies.		**CO1, CO2, CO3, CO4**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. Ned Mohan, M. Underland, and William P. Robbins, “Power Electronics Converters, Applications and Design”, John Wiley & Sons, Singapore, 2001.
2. P.S. Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 2025.
3. M.D. Singh and K.B. Khanchandani, *Power Electronics*, McGraw Hill Education, 2017.
4. Cyril W. Lander, *Power Electronics,* McGraw-Hill Inc. 1993.
5. Muhammad H.Rasid, *Power Electronics- Devices, circuits, and Applications*, Person Education, 2017.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	3	-	-	3	-	3	2	1	2
CO2	3	3	3	3	2	2	-	-	2	-	1	2	1	1
CO3	3	3	3	3	1	2	-	-	2	-	1	3	1	1
CO4	2	3	3	3	3	3	-	-	2	-	3	2	1	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC115	**Linear Integrated Circuits**	3	-	-	3	40	60	100
Prerequisite:	Analog Electronics							

Course Outcome: At the end of the course students will be able to		
	CO1	Explore the fabrication techniques of integrated circuits, including monolithic IC technology and the manufacturing process of FETs.
	CO2	Analyze the characteristics and applications of operational amplifiers, such as inverting/non-inverting amplifiers, comparators, rectifiers, and instrumentation amplifiers.
	CO3	Examine the design and working principles of voltage regulators and data converters, including DAC and ADC with different conversion techniques.
	CO4	Design and implement active filters and waveform generators to develop oscillators, multivibrators, and various signal processing circuits.
	CO5	Investigate the functionality and applications of PLL and timer circuits, focusing on frequency synthesis, demodulation, and pulse detection.

UNIT-I	**Integrated Circuit Fabrication**	**Periods: 9**
Introduction – Classification – IC chip size and circuit complexity – Fundamentals of Monolithic IC technology – Basic Planar Processes – Fabrication of a typical circuit – Fabrication of FET.		**CO1**
UNIT-II	**Operational Amplifiers and Its Characteristics**	**Periods: 9**
Introduction to Linear ICs -Operational amplifier IC 741 Block diagram and Characteristics – Ideal and practical. Inverting, non-inverting and difference amplifier. Adder, Subtractor, Integrator, Differentiator- Comparator- Window detector- Regenerative comparator (Schmitt trigger) - Precision rectifier- Log and antilog amplifiers, Instrumentation amplifiers.		**CO2**
UNIT-III	**Voltage Regulators & A-D and D-A Converters**	**Periods: 9**
Voltage Regulators-Series /shunt op-amp regulator, IC Voltage Regulator. Digital to Analog converters: specifications-types- weighted resistor type, binary ladder, testing of DAC. Analog to Digital converter: specifications-types- counter ramp, flash converter, successive approximation and dual slope converters.		**CO2, CO3**
UNIT-IV	**Active Filters and Waveform Generators**	**Periods: 9**
First and second order Active filters-Low pass, High pass, Band pass and Band reject filters- characteristics, Higher order filters. Oscillators-RC Phase shift and Wien-bridge oscillators. Multivibrators - Monostable and Astable operation. Waveform generator-Square, Triangular and sawtooth waveform generators.		**CO2, CO4**
UNIT-V	**Phase Lock Loop and Timers**	**Periods: 9**
Building blocks of PLL - Characteristics - Derivations of expressions for Lock and Capture ranges. PLL IC 565, Applications- Frequency Synthesis - Frequency Translation- FM/AM Demodulation. 555 Timer- Functional block diagram, pin details and description-Monostable and Astable operation - Schmitt trigger-Missing pulse detector-dual timer IC556-Applications		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. Ramakant A. Gayakwad, "Op-Amps and Linear integrated circuits", PHI Pvt Lid, Fourth Edition, 2002
2. D. Roy Choudhury, Shail B. Jain, Linear Integrated Circuits, New Age International (P) Ltd, Fourth Edition, paperback 2017.
3. Robert F. Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2009.
4. Paul R. Gray, Paul J. Hurst , Stephen H. Lewis, Robert G. Meyer , "Analysis and Design of Analog Integrated Circuits", Wiley International, Fifth Edition , 2009.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3	3	3	-	-	-	2	-	1	2	1	-
CO2	2	3	3	3	3	-	-	-	2	-	1	2	1	-
CO3	2	3	3	3	3	-	-	-	2	-	1	2	1	-
CO4	2	3	3	3	3	-	-	-	2	-	1	2	1	-
CO5	2	3	3	3	3	-	-	-	2	-	1	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC116	**Transmission and Distribution**	3	-	-	3	40	60	100
Prerequisite:	Electric Circuit Analysis, Control Systems							

Course Outcome: At the end of the course students will be able to		
	CO1	Understand the structure of Electric Power system and to calculate the line parameters of the transmission line
	CO2	Analyse the performance of different types of transmission lines and study the effect of Corona on transmission lines
	CO3	Evaluate the mechanical design of overhead lines and underground cables of transmission lines
	CO4	Analyse the different types of tests for insulators and UG cables
	CO5	Understand the voltage distribution in AC and DC distribution systems for different types of loading

UNIT-I	**Transmission Line Parameters**	**Periods: 9**
Structure of Electric Power System – One line diagram - Parameters of single and three phase transmission lines -Resistance, inductance and capacitance of solid, stranded and bundled conductors, Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects -Typical configurations, conductor types and electrical parameters of EHV lines.		**CO1**
UNIT-II	**Performance of Transmission Lines & Corona**	**Periods: 9**
Performance of Transmission lines - short line, medium line and long line - equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance - transmission efficiency and voltage regulation, real and reactive power flow in lines - Power Circle diagrams - Formation of Corona – Factors affecting corona-Critical Voltages – Effect on Line Performance.		**CO2**
UNIT-III	**Mechanical Design of Transmission Lines**	**Periods: 9**
Mechanical design of over head lines – Line Supports –Types of towers – Stress and Sag Calculation – Effects of Wind and Ice loading. Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators.		**CO3, CO4**
UNIT-IV	**Underground Cables**	**Periods: 9**
Underground cables - Types of cables – Construction of single core cable - Insulation Resistance – Potential Gradient - Capacitance of Single-core and 3 core cables - Grading of cable - Power factor and heating of cable. Testing of Cables.		**CO3, CO4**
UNIT-V	**Distribution Systems**	**Periods: 9**
Distribution Systems – General Aspects –AC and DC distributions –Radial and Ring main systems – Concentrated, uniform and combined loading - Kelvin's law for the design of feeders – Techniques of voltage control and power factor improvement – Recent trends in transmission and distribution: EHVAC, HVDC and Flexible AC transmission systems (FACTS) (Qualitative treatment only).		**CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. D.P. Kothari, I.J. Nagarath, 'Power System Engineering', McGraw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.
2. C.L. Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, Seventh Edition, 2018.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011.
4. V.K. Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi, 2022.
5. Luces M. Fualken berry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 2007

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	-	-	-	-	-	2	1	2
CO2	3	3	3	3	3	2	-	-	-	-	-	2	1	2
CO3	3	3	3	3	2	-	-	-	-	-	-	2	1	2
CO4	2	2	2	3	2	-	-	-	-	-	-	0	1	1
CO5	3	3	3	3	3	2	-	-	-	-	-	1	0	2

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**			Programme: **B.Tech.(EE)**						
Semester : **Fifth**			Course Category Code: **PCC**			Semester Exam Type: **TY**			
Course Code	Course		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC117	**Measurement and Instrumentation**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	Know the basic concepts of Measurement system and static and dynamic characteristics.							
	CO2	Have knowledge of the principle and construction of measuring Instruments.							
	CO3	Analyse the principle and construction of different type of measuring Instruments.							
	CO4	Familiarize the working principle of display and recording devices.							
	CO5	Acquire knowledge on different types of transducers.							
UNIT-I	**Introduction to Measurement**					**Periods: 9**			
Elements of Generalized measurement system- Methods of measurement- Classification of instruments– Mean, Standard deviation- Probability of errors- problems- Types of error and remedial measures, Static & Dynamic characteristics of instruments.									**CO1**
UNIT-II	**Electrical Measuring Instruments**					**Periods: 9**			
Basic effects of electromechanical instruments–Ammeter and voltmeter–Moving coil–Moving Iron–Electro dynamo meter–Extension of range. Wattmeter–Dynamometer and induction type energy meter Instrument transformers. Power factor meter– Synchroscope– Frequency meter.									**CO1** **CO2**
UNIT-III	**Bridges and Magnetic Measurement**					**Periods: 9**			
Measurement of resistance- Low, Medium and High- AC bridges- Maxwell, Hay's and Anderson's bridge for inductance. Desauty's bridge and Schering Bridge for Capacitance and Wien's bridge for measurement of frequency. B-H curve and hysteresis loop using ballistic galvanometer, and Loss measurement using Wattmeter method.									**CO2** **CO3**
UNIT-IV	**Display and Recording Devices**					**Periods: 9**			
LED & LCD Display, Dot Matrix Display, 7-Segment Display, Strip Chart Recorders, Single point and multipoint Recorders– X-Y Recorders-Magnetic Tape Recorders-Data Loggers– Electromagnetic and Electrostatic interference, Data Acquisition system.									**CO1** **CO4**
UNIT-V	**Transducers**					**Periods: 9**			
Temperature transducers-RTD, thermistor, Thermocouple-Displacement Transducer-Inductive, capacitive, LVDT, Pressure transducer–Bourdon tube, Bellows–Flow transducer– Electromagnetic flow meter – Strain gauges– Piezoelectric and Hall Effect transducer.									**CO1** **CO5**
Lecture Periods: 45	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 45**			

Reference Books:

1. A.K. Sawhney, A course of Electrical & Electronics Measurements & Instrumentation, Dhanpat Rai & sons, 2010.
2. Arun K. Ghosh, Introduction to Measurements and Instrumentation, Prentice Hall of India private limited, 2012.
3. R.K. Rajput, Electrical and Electronic Measurement and Instrumentation, S. Chand and Co. Pvt ltd,2016.
4. John P. Bentley, Principles of Measurement System, Addison Wesley Longman Pvt. Ltd., 2002.
5. G.S. Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw Hill, 2001.
6. D.V.S. Moorthy, Transducers & Instrumentation, Prentice Hall of India, 2008.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	-	-	-	2	2	1
CO2	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO3	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO4	2	2	2	2	1	2	-	-	-	-	2	1	1	1
CO5	2	2	2	2	1	2	-	-	-	-	2	2	2	1

Department: **Humanities & Social Sciences**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **AEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
HSUA105	**Industrial Economics and Management**	2	-	-	2	40	60	100
Pre-requisite								

Course Outcome At the end of the course students will be able to	**CO1**	Demonstrate economic theories, revenue and cost concepts and set of analytical techniques applied to a variety of economic (and non-economic) and financial management issues.
	CO2	Implement various management techniques based on the needs
	CO3	Apply financial planning and Interpret company's income statements and balance sheets to ascertain the financial position of a company.
	CO4	Apply production planning, project scheduling and financial analysis to economic investment and project management problems.
	CO5	Understand fundamental marketing concepts, apply them to real-world scenarios, and develop effective marketing strategies.

UNIT-I	**Micro and Macro Economics and its Applications**	**Periods:6**
Nature and Scope of Economic science – Micro Economics: Economic decisions and Technical decisions, Demand and Supply concepts, Market Equilibrium, Elasticity of Demand, Various concepts of Cost – Break Even Analysis – Market structure. Macro Economics: Measures of National Income – Inflation – Business Cycle.		**CO1**
UNIT-II	**Management Techniques**	**Periods:6**
Introduction to Management – Functions of Management – F.W.Taylor's Scientific Management – Henry Fayol's Principles of Management. Forms of Business Organization, and Types of (Ownership) of a firm.		**CO2**
UNIT-III	**Industrial Finance**	**Periods:6**
Need for Finance –Types of finance – Sources of finance. Final Accounts - Preparation of Trading, Profit and loss Account and Balance Sheet.		**CO3**
UNIT-IV	**Production Management**	**Periods:6**
Types of Production system – Production Planning and control: Planning, Routing, Scheduling, Inspection and Dispatches. Concepts of Productivity – Measurement of Productivity.		**CO4**
UNIT-V	**Marketing Management**	**Periods:6**
Core Concepts of Marketing – Marketing Vs Selling – Channels of Distribution – Promotion Vs. Advertising – Market Research Vs Marketing Research.		**CO5**

Lecture Periods: 30	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 30**

Reference Books

1. Varshney Maheswari, Managerial Economics, S Chand & Co, New Delhi, 2011.
2. Dutt & Sundaram, Indian Economy, S Chand & Co, New Delhi, 2015.
3. Pandey I.M, Elements of Financial Management Wiley Eastern Ltd, New Delhi, 2015.
4. H.L. Ahuja, Macro Economics for Business and Management, S Chand & Company Ltd, 2011.
5. O.P Khanna, Industrial Engineering and Management, Dhanpat Rai and Sons, 2009.
6. Philip B Kotler, Marketing Management, Mac Millan, NewYork, 2011.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	1	-	-	-	3	-	-	-	-	2
CO2	-	-	-	-	-	-	-	-	-	3	2
CO3	-	1	-	-	-	-	-	-	-	3	2
CO4	-	-	-	-	-	-	-	-	-	3	2
CO5	-	-	-	-	-	-	-	-	-	3	2

Score: 3 – High; 2 – Medium; 1 – Low

Department **: Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Fifth**			Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC118	**Linear Integrated circuits Laboratory**		-	-	3	1.5	40	60	100
Prerequisite:	Analog Electronics, Digital Electronics								
Course Outcome: At the end of the course students will be able to	**CO1**	Design and analyze analog signal processing circuits, including amplifiers, adders, subtractors, integrators, differentiators, and precision rectifiers using IC 741.							
	CO2	Develop and test waveform generation and oscillator circuits, such as active filters, Wein-bridge and phase-shift oscillators, and voltage-controlled oscillators.							
	CO3	Implement and evaluate nonlinear and switching circuits, including Schmitt triggers, comparators, monostable and astable multivibrators, and optocoupler-based driver circuits.							
	CO4	Examine voltage regulation and conversion techniques, including digital-to-analog conversion and voltage regulators for stable power supply applications.							
Any 10 Experiments									
1. Inverting and Non-Inverting Amplifier using IC 741 2. Analog Adder, Subtractor and Difference Amplifier using IC 741. 3. Integrator and Differentiator using IC 741.									**CO1**
4. Log and Antilog amplifier circuits using IC741. 5. Precision rectifiers using IC741. 6. Digital to Analog Converter circuits using IC 741.									**CO1, CO3, CO4**
7. Active filter circuits using IC741. 8. Wein-bridge oscillator using IC741. 9. RC Phase-shift oscillator using IC741.									**CO2**
10. Instrumentation amplifier using IC741. 11. Comparator and Schmitt trigger using IC741. 12. Monostable and Astable circuits using IC555.									**CO1, CO3**
13. Voltage Controller Oscillator (VCO) using Phase-locked loop IC NE 565. 14. Optocoupler IC 6N137 based driver circuit. 15. Voltage regulator using IC723.									**CO2, CO4**
Lecture Periods: 0	**Tutorial Periods: 0**		**Practical Periods: 45**				**Total Periods: 45**		

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	2	-	1	3	3	2	1	-
CO2	3	3	3	3	-	-	2	-	1	3	3	2	1	-
CO3	3	3	3	3	-	-	2	-	1	3	3	2	1	-
CO4	3	3	3	3	-	-	2	-	1	3	3	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.(EE)**						
Semester : **Fifth**			Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC119	**Measurement and Control Laboratory**		-	-	3	1.5	40	60	100
Prerequisite	Measurement and Instrumentation, Control Systems								
Course Outcome: At the end of the course students will be able to	**CO1**	The students will be able understand the principles of Bridges and Magnetic measurements.							
	CO2	The students will be able to calibrate the energy meter and extend the range of voltmeter and ammeter.							
	CO3	The students have been introduced to the concept of Transducer & Instrumentation Devices.							
	CO4	The students will be able to determine the transfer function of the DC generator and understand the various functions of the MATLAB for basic control system-oriented problems.							
	CO5	The students will know to draw the various plots in control system using MATLAB.							

Any 10 experiments:

1. Measurement of medium resistance using bridge. 2. Determination of Hysteresis loop using Transformer core.	**CO1**
3. Calibration of single phase/three phase energy meter. 4. Experiment on extending the range of Voltmeter and voltmeter by multiplier and shunt.	**CO2**
5. Measurement of various parameters using Transducer. 6. Determination of the characteristics of Instrumentation amplifier.	**CO3**
7. Determination of the transfer function of the DC generator 8. Analysis of various MATLAB functions for conversion among transfer function, state space and ZPK and block reduction using series, parallel and feedback functions.	**CO4** **CO5**
9. Time response of first and second order system on various input signal using MATLAB. 10. Drawing different plots using MATLAB (Bode plot and Polar plot & Root Locus)	**CO4** **CO5**

Lecture Periods: 0	**Tutorial Periods: 0**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books

1. Laboratory Manual, Department of EEE, Pondicherry Engineering College, Puducherry.

CO-PO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO2	PSO3
CO1	2	2	2	2	1	2	-	3	-	-	2	1	1	1
CO2	2	2	2	2	1	2	-	3	-	-	2	1	1	1
CO3	2	2	2	2	1	2	-	3	-	-	2	1	1	1
CO4	2	2	2	2	2	-	-	3	-	-	2	1	1	1
CO5	2	2	2	2	2	-	-	3	-	-	2	1	1	1

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**					
Semester : **Fifth**			Course Category Code: **HNC**			Semester Exam Type: **TY**		
EEUH102	**Advanced Control Systems**		Periods / Week			Credit	Maximum Marks	
			L	T	P	C	CA	SE	TM
			3	1	-	4	40	60	100
Prerequisite:	Control Systems							
Course Outcome At the end of the course, the students will be able to	**CO1**	Design compensators to meet out performance specifications on transient and steady state response.						
	CO2	Synthesis state feedback controller for linear dynamical system with measurable state variables using pole-placement approach.						
	CO3	Design state feedback controller for linear dynamical system with unmeasurable state variables using pole-placement approach.						
	CO4	Interpret the concept of discrete-time control systems and methodologies to determine the stability of such systems.						
	CO5	Synthesize optimal state feedback controllers for continuous and discrete-time state space systems using LQR approach.						
UNIT-I	**Design of Compensators**					**Periods: 12**		
Design of compensators – Lead, Lag and Lead-Lag types using root locus and Bode plot (frequency domain) - Controller topologies – Feedback and Feed-forward – Classical PID Control Design using Ziegler-Nichols tuning method. Use of AI technique for PI/PID controller design.								**CO1**
UNIT-II	**Design of State Feedback Controller**					**Periods: 12**		
Revisiting Controllability concept – Correlating pole location and transient response - Significance of dominant pole-pair – Necessary and sufficient condition for arbitrary pole placement. Design of state feedback controller using direct state feedback. Computation of State feedback controller using Direct substitution technique, Similarity transformation approach and Ackermaan formula. Design of Servo systems - Design of state feedback controller with integral error compensation.								**CO2**
UNIT-III	**Design of Observer based State Feedback Controller**					**Periods: 12**		
Revisiting Observability concept – State estimation using full order observer and reduced order observer using pole placement approach - computation of observer gains using Direct substitution technique, Similarity transformation approach and Ackermaan formula – Design of observer based state feedback controller – Separation principle.								**CO2, CO3**
UNIT-IV	**Digital Control System**					**Periods: 12**		
Digital control system - Sampling process – ADC and DAC circuits – sample/hold circuit – Data reconstruction – zero-order hold circuit. Sampling Theorem. Ascertaining stability of digital control systems using Jury's stability criterion and Routh's test. State-space representation of sampled data systems.								**CO2, CO4**
UNIT-V	**Synthesis of Optimal Controller**					**Periods: 12**		
Introduction to Optimal Control - Performance measures for Optimal control of Dynamical System – Linear Quadratic Regulator (LQR) problem formulation - Design of optimal state feedback control using Continuous-Time Algebraic Riccatti Equation (CARE). Design of state feedback control for discrete-time control systems – direct state feedback – observer based feedback and LQR controller design using Discrete-Time Algebraic Riccatti Equation (DARE).								**CO2, CO3, CO5**
Lecture Periods: 45	**Tutorial Periods: 15**		**Practical Periods: 0**			**Total Periods: 60**		

Reference Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall, 2010.
2. I J Nagrath and M. Gopal, "Control Systems Engineering", New Age International (P) Limited, 2008.
3. Norman S Nise, "Control Systems Engineering", 7th Edition, Wiley, 2015.
4. Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", 8th Edition, Pearson, 2018.
5. Katsuhiko Ogata, "Discrete-Time Control System", Second Edition, Prentice Hall, 2005.
6. John S Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill Series in Electrical Engineering, 1998.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	-	-	-	-	-	-	3	2	1
CO2	3	3	1	2	2	-	-	-	-	-	-	3	2	1
CO3	3	2	2	2	2	-	-	-	-	-	-	3	2	1
CO4	2	3	2	2	1	-	-	-	-	-	-	3	2	1
CO5	3	3	1	2	1	-	-	-	-	-	-	3	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester: **Sixth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC120	**Power System Analysis**	3	-	-	3	40	60	100
Prerequisite:	Transmission and Distribution							

Course Outcome: At the end of the course students will be able to	**CO1**	Learn and model power system components, including generators, transmission lines/cables, transformers, shunt elements, and loads.
	CO2	Develop network matrices for power systems, formulate power flow problems, and develop solutions using Gauss, Gauss-Seidel, Newton-Raphson, and fast decoupled methods.
	CO3	Understand the concepts of symmetrical components and sequence networks of power system components.
	CO4	Analyse the symmetrical and unsymmetrical faults and determining fault voltages and currents for various types of faults.
	CO5	Acquire knowledge on estimating the stability of the system

UNIT-I	**Modelling of Power Systems Components**	**Periods: 9**	
Need for system planning and operational studies – Single line diagram of power system components – Per unit quantities – Reactance diagram - Bus admittance matrix – Bus impedance matrix representation.			**CO1**
UNIT-II	**Load Flow Studies**	**Periods: 9**	
Bus Classification - Formulation of load flow equations using Gauss-Seidel, Newton-Raphson and Fast Decoupled method for the computation of slack bus power - line voltages, line losses and real and reactive powers transmitted through the line - Comparison of the above methods.			**CO1, CO2**
UNIT-III	**Symmetrical Components**	**Periods: 9**	
Introduction of symmetrical components - Transformation matrices used in resolution of unbalanced voltages and currents- Positive, Negative and Zero sequence networks of power system components like synchronous machines, induction machines, transformers, transmission lines, loads.			**CO1, CO3**
UNIT-IV	**Symmetrical and Unsymmetrical Fault Analysis**	**Periods: 9**	
Symmetrical fault analysis - analysis through impedance matrix - circuit breaker rating - current limiting reactors. Unsymmetrical fault analysis - LG, LL, LLG and open circuit faults – analysis through sequence components.			**CO1, CO4**
UNIT-V	**Power System stability**	**Periods: 9**	
Stability studies - Steady state and Transient stability – Power Angle Curve - Swing equation – Swing Curve – Solution of Swing equation by Step-by-Step method -Equal area criterion – Critical clearing angle and Clearing time			**CO1, CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. "Modern Power System Analysis" Chee – Wooi Ten and Yunhe Hou: 3rd Edition, CRC Press 2024.
2. "Power System Analysis and Design" by J. Duncan Glover, Mulukutla S. Sarma, Thomas Overbye, and Adam Birchfield: 7th Edition Cengage Learning 2022.
3. "Modern Power System Analysis "by D.P. Kothari and I. J. Nagrath 5th Edition McGraw – Hill Education 2022.
4. "Power System Analysis" by Hadi Saadat: 3rd Edition PSA Publishing 2010.
5. "Computer Techniques in Power System Analysis" by M. A. Pai Revised Edition 2005, Tata McGraw Hill Education.
6. "Power System Analysis" by John. J. Grainger & Stevenson. W. D., 2nd Edition Pearson Publishing, 1999.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	-	-	2	-	1	2	1	-
CO2	3	3	2	3	2	-	-	-	2	-	1	2	1	-
CO3	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO4	3	3	3	3	3	-	-	-	2	-	1	2	1	-
CO5	3	3	2	3	2	-	-	-	2	-	1	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC121	**Microprocessors and Microcontrollers**	3	-	-	3	40	60	100
Prerequisite:	Digital Electronics							
Course Outcome: At the end of the course students will be able to	**CO1**	Explain the fundamental concepts and architecture of microprocessors and microcontrollers						
	CO2	Write assembly language programs using 8 bit microprocessors and microcontrollers						
	CO3	Interface using serial communication and programmable peripheral ICs.						
	CO4	Design microprocessor and microcontroller based applications.						

UNIT-I	**Introduction to Microprocessor**	**Periods: 9**
Introduction to Microprocessor - Architecture of 8085 Microprocessor – Registers, ALU, Bus systems, Timing and control unit, Interrupts and Serial I/O-external memory –Input & output devices, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O and I/O mapped I/O. Introduction to the architecture of 8086 microprocessor.		**CO1**
UNIT-II	**Basic Programming concepts**	**Periods: 9**
Machine Language and Assembly Language-Addressing modes--types of instruction format-Data Transfer type instructions-Arithmetic and logical instructions–Branching instructions--I/O and Machine Control Instructions. Looping and time delay –stack and subroutines-system clock-T-state-instruction and machine cycles-Timing diagram, assembly language programs-arithmetic and logical operations on Binary/BCD numbers, sorting, code conversions, generation of series		**CO2**
UNIT-III	**Communication and Peripheral ICs**	**Periods: 9**
Peripheral ICs (Block diagram, features and interfacing only)-Programmable Peripheral device (8255), Timer/ Counter (8253), Programmable keyboard display interfaces (8279). Programmable interrupt controller (8259) - Serial communication USART (8259). Interfacing Data converters, stepper motor interfacing, and traffic lights.		**CO3, CO4**
UNIT-IV	**The 8051 Microcontroller- Architecture and Programming**	**Periods: 9**
Block Diagram of 8051 Microcontroller -CPU, Oscillator, Program memory, Data memory, Stack Pointer, Special Function Registers, I/O ports. Addressing modes- Immediate, Register, Direct, Indirect, Relative and Indexed addressing, bit inherent addressing, bit direct addressing, PUSH and POP instructions. Logical operators-bit and byte level, bit level Boolean operators, Rotate and swap, Example programs. Arithmetic operations- addition, subtraction, multiplication, division, Decimal Arithmetic, searching and sorting. Jump and Call Subroutines.		**CO1, CO2**
UNIT-V	**Interfacing with 8051 and Advanced Microcontrollers**	**Periods: 9**
LCD and Keyboard Interfacing, ADC, DAC & Sensor Interfacing, External Memory Interface, Stepper Motor and Waveform generation. Introduction to ARM and PIC microcontroller. Introduction to protocols like Blue-tooth and Zig-bee.		**CO3, CO4**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Reference Books:

1. Ramesh Gaonkar, “Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, Sixth Edition 2013.
2. K. J. Ayala, “8051 Microcontroller”, Cengage Learning India; 3rd edition, 2007.
3. D. V. Hall, “Microprocessors and Interfacing”, McGraw Hill Higher Education, Third Edition, 2017.
4. N.Senthil Kumar, M.Saravanan and S.Jeevananthan, “Microprocessors and Microcontrollers”, 2nd Edition, Oxford University Press-2018.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1	-	-	-	-	-	-	1	2		
CO2	3	3	3	3	-	-	-	-	-	-	2	2		2
CO3	2	2	1	1	-	-	-	-	-	-	1	2		2
CO4	3	3	3	2	-	-	-	-	-	-	2	2		2

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech. (EE)**						
Semester: **Sixth**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC122	**Artificial Intelligence**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to		
	CO1	Understand the evolution of Artificial Intelligence, from its origins to its growing impact on industries and society – Problem solving techniques.
	CO2	Analyse the differences between human and machine intelligence, neural network architectures, and their applications in power systems.
	CO3	Study of fuzzy logic, its foundational concepts, mathematical operations, inference techniques, and defuzzification methods.
	CO4	Apply AI planning techniques, decision-making under uncertainty, and diverse learning paradigms, including supervised, unsupervised, and reinforcement learning."
	CO5	Explore the Artificial Intelligence in Power Systems - Applications in Voltage Control, Security Assessment, Maintenance, Demand Forecasting, Automation, Renewable Energy, Electric Vehicles, and Smart Grids.

UNIT-I	**Evolution and Impact of Artificial Intelligence:**	**Periods: 9**	
Evolution of AI - Problem-solving techniques: state-space - Blind search techniques: BFS, DFS, UCS, - Heuristic search techniques: Best-first search, Greedy search, A* search, AO* search- Adversarial search: Mini-max search - alpha-beta cut off.			**CO1**
UNIT-II	**Intelligent Neural Systems**	**Periods: 9**	
Difference between human machine and intelligence, biological neural network, artificial neuron model, Concept of Perceptron, ADALINE, Feedback in Neural Network, Neural Network Architectures: Neural Learning, Application of Neural Network in Power System.			**CO2**
UNIT-III	**Computational Intelligence**	**Periods: 9**	
Fuzzy Logic: Introduction, Foundation of Fuzzy Systems, Representing Fuzzy Elements, Basic Terms and Operations, Properties of Fuzzy Sets, Fuzzification, Arithmetic Operations of Fuzzy Numbers, the alpha cut method, The extension method, Linguistic Descriptions and their Analytical Forms, Fuzzy Linguistic Descriptions, Fuzzy Relation Inferences, Fuzzy Implication and Algorithms, Defuzzification Methods, Centre of Area Defuzzification, Centre of Sums Defuzzification.			**CO3**
UNIT-IV	**Cognitive Planning and Learning in AI**	**Periods: 9**	
Planning: State space planning - partial order planning - Planning graphs - Conditional Planning- Continuous planning, planning under uncertainty - Learning Types: Rote Learning, learning by taking advice, Explanation based learning, Discovery, Analogy - Supervised and Unsupervised learning - Decision trees-based learning – Reinforcement Learning.			**CO2, CO3, CO4**
UNIT-V	**Applications of Artificial Intelligence to Electrical Engineering**	**Periods: 9**	
Application of AI - Voltage Control - Security assessment- Schedule Maintenance of Electrical Power Transmission Networks - Demand Forecasting - Industrial Automation - Renewable Energy Systems- Electric Vehicles - Smart Grids			**CO2, CO3 CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. "Fundamentals of Artificial Neural Networks" by Mohamad H. Hassoun ist edition MIT Press, 2003
2. Fuzzy Logic: An Introductory Course for Engineering Students" Enric Trillas and Luka Eciolaza. Springer 2015.
3. "A First Course in Fuzzy Logic" is authored by Hung T. Nguyen, Carol L. Walker, and Elbert A. Walker 4th edition Chapman and Hall/CRC 2018.
4. Artificial Intelligence and Intelligent Systems by N. P. Padhy 1st edition Oxford University Press, 2005
5. Artificial Intelligence Techniques in Power Systems by Kevin Warwick, Arthur Ekwue, and Raj Aggarwal: Institution of Engineering & Technology, 1997
6. Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications by Stamations V. Kartalopoulos: Prentice Hall India Private Limited, 2002
7. AI for Power Electronics and Renewable Energy Systems by Weihao Hu; Guozhou Zhang; Zhenyuan Zhang; Sayed Abulanwar; Frede Blaabjerg, ist edition Institution of Engineering & Technology (IET) 2024.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	-	-	-	1	-	1	2	1	-
CO2	3	3	2	3	1	-	-	-	2	-	1	2	1	-
CO3	3	3	3	3	1	-	-	-	2	-	1	2	1	-
CO4	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO5	3	3	2	3	2	-	-	-	2	-	1	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low

Department : Electrical and Electronics Engineering		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC123	**Microprocessor and Microcontroller Laboratory**	-	-	3	1.5	40	60	100

Prerequisite:

Course Outcome At the end of the course student will be able to		
	CO1	Formulate efficient algorithms for performing arithmetic and logical operations with an understanding of computational logic and problem-solving techniques.
	CO2	Write assembly language programs for microprocessor/microcontroller systems.
	CO3	Test, debug, and execute assembly language programs using 8085 and 8051-based trainer kits.
	CO4	Interface various peripherals with microprocessors/microcontrollers.

Any 10 experiments:

8085 Microprocessor based experiments: 1. Binary arithmetic operations (8/16-bit) 2. BCD arithmetic operations. 3. Block operations 4. Generation of Series(Fibonacci, prime)	**CO1, CO2, CO3**
5. Message Display (Moving &Flashing). 6. Digital clock Simulation using counters/interrupts.	**CO1, CO2, CO3**
8051 Microcontroller based experiments 7. Arithmetic operations 8. Code conversions 9. Array operations (searching, sorting)	**CO1, CO2, CO3**
Interfacing experiments (8085/8051 based) 10. Traffic light interface. 11. Display Interface. 12. Stepper motor interface.	**CO1, CO2, CO3, CO4**

Lecture Periods:	**Tutorial Periods:**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

1. Laboratory Manual, Department of EEE, Puducherry Technological University, Puducherry.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	-	2		
CO2	3	2	2	2	-	-	-	-	-	-	-	2		
CO3	3	2	2	3	3	-	-	3	-	-	-	2		
CO4	3	3	3	3	-	-	-	3	-	-	2	2	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.(EE)**						
Semester : **Sixth**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC124	**Power Electronics Laboratory**	-	-	3	1.5	40	60	100
Prerequisite								

Course Outcome: At the end of the course students will be able to		
	CO1	Demonstrate the characteristics of power semiconductor devices, develop the firing circuits for SCR triggering and examine the forced commutation methods.
	CO2	Analyze and operate various power converters, such as rectifiers, inverters, choppers, and cycloconverters, with different load types (resistive, inductive) to understand their performance and applications.
	CO3	Utilize software tools like MATLAB to model, simulate and validate power electronic circuit designs.
	CO4	Apply Power Electronics concepts to real world scenarios such as motor drives, renewable energy systems.

Any 10 experiments:

(A) Experimental Verification	
1. Switching characteristics of SCR, MOSFET and IGBT 2. RC and UJT Triggering circuits for SCR 3. Voltage commutation 4. Current commutation	**CO1**
3. Single phase semi-converter with R and RL loads 5. Single Phase Full converter with R and RL loads 6. Three-phase Semi converter with R and RL loads 7. Three-phase Full converter with R and RL loads	**CO2**
8. Single-phase Series Inverter 9. Single-phase Parallel Inverter 10. Single-phase VSI with different modulation techniques 11. Single-phase AC Voltage controller with R and RL loads 12. Single-phase cycloconverter	**CO2**
(B) Simulation Study 13. Single-phase semi- and full- converters 14. Three phase semi and full converters 15. Class A and B choppers 16. Three-phase VSI under 120 and 180 degrees of operation	**CO2,** **CO3**
(C) Application of Power Converters 17. Speed control of DC motor using Rectifier/Chopper. 18. Indoor PV based battery charging system. 19. Speed control of induction motor using Voltage source inverters	**CO2,** **CO4**

Lecture Periods: 0	**Tutorial Periods: 0**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books

1. Laboratory Manual, Department of EEE, Puducherry Technological University, Puducherry.
2. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi, Seventh Edition, 2022.
3. Muhammad H. Rashid: Power Electronics Circuits, Devices and Applications, Pearson Education,4th edition n 2017
4. M.D. Singh, and K.B. Khanchandani, Power Electronics, Tata McGraw Hill, New Delhi, Second Edition, 2017.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	2	-	3	2	-	1	3	2	2
CO2	3	2	3	3	3	2	-	3	2	-	2	3	3	2
CO3	2	3	3	3	3	2	-	3	2	-	2	3	3	3
CO4	3	2	2	3	3	2	-	3	2	-	2	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Sixth**			Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC125	**Internship**		-	-	-	2	100	-	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	Apply knowledge acquired through coursework to practical projects and real-world tasks.							
	CO2	Develop essential soft skills including effective communication, teamwork, problem-solving, and time management.							
	CO3	Demonstrate the ability to adapt to professional environments, handle real-world challenges, and utilize relevant industry tools and technologies proficiently.							

The student is required to undergo Internship in industry / research laboratory / higher learning institution for a period of at least 4 weeks in a maximum of 2 spells during vacations. Each spell of internship shall be for a period of not less than 2 weeks. The primary objective of the internship is to enhance the student's professional perspective and practical capabilities, thereby improving their career readiness and employment prospects. Prior to commencing the internship, students must obtain formal approval from the Head of the Department. Upon completion, a comprehensive internship report must be submitted for evaluation. A departmental committee shall evaluate the performance of the students.	**CO1, CO2, CO3**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	-	3	1	2	1	3	3	2
CO2	2	2	2	2	2	2	1	3	1	2	2	3	3	2
CO3	3	1	2	2	2	2	1	3	2	2	2	3	3	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **HNC**				Semester Exam Type: **TY**		
Course code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUH103	**Power Electronics in Power Systems**	3	1	-	4	40	60	100
Prerequisite:	Power Electronics							

Course Outcome: At the end of the course students will be able to		
	CO1	Explain Reactive Power Compensation and Control
	CO2	Analyze and design Solid-State Controlled Compensators
	CO3	Evaluate the Role of FACTS Devices in Power Flow Control
	CO4	Examine Excitation Systems and UPS for Power System Reliability
	CO5	Assess HVDC Converters, Control Strategies, and Power Quality

UNIT-I	**Reactive Power Compensation and Regulation**	**Periods: 12**
Power system components - representation of single line diagram - compensators types, principles of reactive power control - introduction to load compensation - line compensation - P and Q control - phase angle regulation. Load compensation - voltage regulation - power factor correction - phase balance unsymmetrical loads. Line compensations - increased power transfer capability - sub synchronous oscillations - mitigations.		**CO1**
UNIT-II	**Solid State Controlled Compensators**	**Periods: 12**
Introduction to conventional compensators - synchronous condenser - saturable core reactor - analysis and design of static compensators - TCR - TSC - SVC - TCSC -modeling and control of static compensators.		**CO1, CO2**
UNIT-III	**Design Of UPFC and Static Tap Changers**	**Periods: 12**
UPFC components - shunt devices - series devices - operation and control - real and reactive power - UPFC parameters and design philosophy. Conventional tap changing methods - solid state tap changer - voltage regulation - different schemes - comparison - specifications - design methods.		**CO2, CO3, CO5**
UNIT-IV	**Static Generator Excitation Systems and UPS**	**Periods: 12**
Solid state excitation of synchronous generators - different schemes - Generator excitation systems - redundancy and reliability. Introduction to high power UPS - types - offline - online, UPS Converter system - high power factor converters - synchronous converters - Green UPS operation - solid state bypass switch and filters.		**CO4, CO5**
UNIT-V	**HVDC Converters and Controls**	**Periods: 12**
HVDC components - kinds of DC links - modern HVDC converters - commutation issues - control characteristics - constant phase angle control - constant current and extinction angle control - twelve and higher pulse operation - introduction to modern converters - protections - reactive power requirements - harmonics - filter types and design of various ac and dc filters.		**CO5**

Lecture Periods: 3	**Tutorial Periods: 1**	**Practical Periods: 0**	**Total Periods: 4**

Reference Books:

1. Miller.T.J.E, Reactive power control in Electric systems, Wiley interscience, NewYork, 1982.
2. R.Mohan and R.K.Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, IEEEPress – A John Wiley and Sons, Inc. Publications.2002.
3. K. R. Padiyar, HVDC Power Transmission Systems Technology and System Interactions, New Age International (p) Limited, New Delhi, 2003.
4. Vijay K.Sood, HVDC and FACTS Controller: Application of Static Converters in power systems, IEEE Power Electronics and Power Systems series, Kluwer Academic publishers, Boston,2004.
5. Narani.G. Hingorani and Laszlo Gyugyi, Understanding FACTS, IEEE Power Engineering society sponsor, IEEE Press.2000.
6. K.R.Padiyar, Facts Controllers in Power Transmission and Distribution, New Age International (P) Limited, Publishers, New Delhi, 2007.
7. “A Static alternative to the transformer on load tap changing”, IEEE Trans. on PAS, Vol.PAS-99, Jan. /Feb. 1980,
8. “Improvements in Thyristor controlled static on- load tap controllers for transformers”, IEEE Trans. on PAS, Vol.PAS-101, Sept.1982, pp. 3091-3095.
9. “Shunt Thyristor rectifiers for the Generator Excitation systems”, IEEE Trans. On PAS. Vol.PAS -96, July/August, 1977,pp1219-1225

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	-	-	1	3	1	2	2	2	1
CO2	3	3	3	3	3	2	-	1	1	2	2	2	2	1
CO3	3	3	3	3	3	2	-	1	2	2	2	2	2	1
CO4	3	3	3	3	3	2	-	1	1	2	2	2	2	1
CO5	3	3	3	3	2	-	-	2	3	2	3	2	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC126	**Power System Operation and Control**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to		
	CO1	Understand the significance of Indian grid and control of a power system.
	CO2	Acquire knowledge on load forecast and unit commitment.
	CO3	Understand the real power - frequency control.
	CO4	Understand the economic operation of power system.
	CO5	Understand the reactive power-voltage control.

UNIT-I	**Preliminaries on Power System Operation and Control**	**Periods: 9**
Power scenario in Indian grid - Power system security- Factors affecting system security- Necessity for regulation of system frequency and voltage- P-F and Q-V control structure - Major concerns of power system design for satisfactory operation -Power systems control problems - Different operating states of power Systems- Energy control centres and its functions-Phasor measurement unit - SCADA systems.		**CO1 CO3 CO5**
UNIT-II	**Load Forecast and Unit Commitment**	**Periods: 9**
Load and load duration curves - Load forecasting - Factors affecting the load forecasting - components of system load- classification of load, Voltage and frequency Load dependency- forecasting of the base load by method of least square fit-Introduction to unit commitments - constraints on unit commitment - unit commitment using priority list method and dynamic programming method.		**CO2 CO4**
UNIT-III	**Real Power - Frequency Control**	**Periods:9**
Power control mechanism of individual machine- Mathematical model of speed governing mechanism- Speed load characteristics of governing mechanism-Regulation of two generators in parallel- Division of power system into control areas-LFC control of a single area; static and dynamic analysis of uncontrolled system- proportional plus integral control of a single area- LFC control of two area system - static and dynamic response-Tie line with frequency bias control of two area.		**CO1 CO3**
UNIT-IV	**Economic Operation of Power System**	**Periods: 9**
Statement of economic dispatch problem - input and output characteristics of thermal plant -incremental cost curve - co-ordination equations with losses neglected- solution by iteration- co-ordination equations with losses included - solution of co- ordination equations using B_{mn} co-efficient (No derivation of B_{mn} co-efficient) - Base point and participation factors - Special aspects of Emission constrained economic dispatch - Price balance penalty factor.		**CO2 CO4**
UNIT-V	**Reactive Power – Voltage Control**	**Periods: 9**
Fundamental characteristics of excitation system - Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop - static and dynamic analysis -Generation and absorption of reactive power- Methods of voltage control-tap changing transformer - Static VAR compensators and STATCOMs - comparisons of different types of compensating equipment for transmission systems.		**CO1 CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. Olle. I. Elgerd, 'Electric Energy Systems theory - An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
2. Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2016.
3. Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
4. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, Second Edition, 2008.
5. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
6. Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd. New Delhi, 10th reprint, 2010.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	-	1	1	1	3	-	-	1	-	1	2	1	1
CO2	2	3	1	2	1	3	-	1	1	2	1	2	1	2
CO3	2	3	1	2	1	3	-	1	1	-	-	2	1	2
CO4	2	3	1	2	1	3	-	1	1	2	-	2	1	3
CO5	2	3	1	2	1	3	-	1	1	-	-	2	1	1

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC127	**Protection and Switchgear**	3	-	-	3	40	60	100

Prerequisite:	Transmission and Distribution, Power System Analysis	
Course Outcome: At the end of the course students will be able to	**CO1**	Understand the fundamental concepts of power system protection, including protection zones, relay coordination, and insulation coordination.
	CO2	Analyze and apply different types of protective relays and their characteristics for system protection.
	CO3	Evaluate various circuit breakers, their operational mechanisms, and their application in fault clearance.
	CO4	Design and implement protection schemes for generators, transformers, transmission lines, and busbars.
	CO5	Explore modern advancements in power system protection, including digital relays, SCADA integration, and cybersecurity aspects.

UNIT-I	**Fundamentals of Power System Protection**	**Periods: 9**
Need for power system protection, basic components of a protection system, zones of protection, types of faults in power systems, symmetrical and unsymmetrical faults. Essential qualities of protection: selectivity, speed, sensitivity, reliability, and stability. Classification of protective schemes, backup protection, and protection coordination. Introduction to overvoltage protection and insulation coordination in power systems.		**CO1 CO2**
UNIT-II	**Protective Relays and Their Characteristics**	**Periods: 9**
Principle of operation of relays, classification of relays—electromagnetic, static, and digital/numerical relays. Characteristics and operation of overcurrent, directional, differential, distance, and admittance relays. Relay settings, coordination, and selectivity. Protection coordination in radial and ring main systems. Introduction to microprocessor-based relays and their applications.		**CO2 CO3**
UNIT-III	**Circuit Breakers and Fault Interruption**	**Periods: 9**
Need for circuit breakers, arc formation and extinction theories, arc quenching methods, types of circuit breakers—air break, oil, SF_6, vacuum, and hybrid circuit breakers. Ratings of circuit breakers, current chopping, restriking voltage, and rate of rise of re-striking voltage (RRRV). Selection of circuit breakers for LV and HV applications. Testing of circuit breakers—type tests and routine tests. Maintenance and troubleshooting of circuit breakers.		**CO3 CO4**
UNIT-IV	**Protection of Generators, Transformers, Transmission Lines, and Busbars**	**Periods: 9**
Protection of alternators against stator and rotor faults, loss of excitation, overvoltage, and unbalanced loading. Transformer protection—differential protection, Buchholz relay, and overcurrent protection. Transmission line protection using distance relays and carrier current protection. Protection of busbars using differential protection schemes and arc flash mitigation techniques.		**CO4 CO5**
UNIT-V	**Recent Trends in Power System Protection**	**Periods: 9**
Digital protection techniques, SCADA and automation in power system protection, wide-area protection systems (WAPS), phasor measurement units (PMUs), adaptive relaying, and artificial intelligence-based protection systems. Introduction to smart grid protection, cyber security in power system protection, and real-time fault diagnosis techniques. Case studies on modern power system protection schemes.		**CO5 CO1**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. B. Ravindranath and M. Chander, Power System Protection and Switchgear, New Age International. 2nd Edition, 2011.
2. C.L. Wadhwa, Electrical Power Systems, 7th Edition, New Age International, 2022.
3. Sunil S. Rao, Switchgear Protection & Power Systems, 13th Edition, Khanna Publishers, 2008.
4. Badri Ram and D. N. Vishwakarma, Power System Protection and Switchgear, 2nd Edition Tata McGraw-Hill, 2011.
5. Y.G. Paithankar and S.R. Bhide, Fundamentals of Power System Protection, 2nd EditionPrentice-Hall India, 2010.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	-	-	2	-	1	3	2	2
CO2	3	3	3	3	2	-	-	-	2	-	1	3	3	2
CO3	3	3	3	3	2	-	-	-	2	-	1	3	3	3
CO4	3	3	3	3	2	3	-	-	2	-	1	3	3	3
CO5	2	2	2	3	2	3	-	-	2	-	1	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.(EE)**						
Semester : **Seventh**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course	Periods / Week			Credit	Maximum Marks: 100		
		L	T	P	C	CA	SE	TM
EEUC128	**Solid State Drives**	3	-	-	3	40	60	100
Prerequisite	DC Machines and Transformers, AC Machines, Power Electronics							
Course Outcome: At the end of the course students will be able to	**CO1**	Understand the mechanical characteristics of different types of electrical motors and loads and learn how to select appropriate motors, controllers, and power converters for a specific application.						
	CO2	Transform the pristine speed control systems of both DC and AC motor into solid state drive system by involving suitable power electronic circuits						
	CO3	Develop the ability to analyze the drive and motor performances through different indices and waveforms at different load conditions						
	CO4	Gain proficiency to develop modern speed control methods for three phase AC motors.						

UNIT-I	**Fundamentals of Electric Drives**	**Periods: 9**
Solid State Electric Drives- Elements and their choices; Electric Motors- Rekindling of torque equations and Mechanical characteristics of different electrical motors, Thermal model, Classes of motor duty, Determination power rating considering thermal overloading and load variation factors, Interpretation of Nameplate Details; (Qualitative Study on IS 12615). Rotational Loads- Fundamental torque equation, Components of load torque; Classification of load torque based on the dominancy of torque components, Selection of motor type; Speed-torque Characteristics for Four Quadrant Operation-Active and passive loads, motoring and breaking; Steady State Stability- Speed torque curve of motor and load combination; Load Equalization.		**CO1**

UNIT-II	**Rectifier DC Drives**	**Periods: 9**
Overview of Speed control of DC motors with basic motor equations; Ward Leonard Scheme- Constant HP and constant torque operation. **Phase Angle Controlled Rectifier DC Drives**: Performance parameters, Single-phase and three-phase semi & fully controlled drives - continuous and discontinuous armature currents, Speed-torque characteristics for different firing angle, Numerical problems. **Closed loop control of DC drive**- Block diagram level understanding of armature voltage control at constant field and Field weakening modes.		**CO2, CO3, CO4**

UNIT-III	**DC Chopper Drives**	**Periods: 9**
Motoring Operation of Separately Excited Motor- Steady state analysis for TRC and CLC; Regenerative Braking of Separately Excited Motor; Multiquadrant Control- Single quadrant chopper Drives (Class A&B) , Two quadrant schemes (Class C &D), Four quadrant Chopper drive (Class E) - Closed loop operation - Related numerical problems.		**CO2, C03, CO4**

UNIT-IV	**Induction Motor Drives**	**Periods: 9**
Review of Speed control methods of Induction motor; **Stator Voltage Control** through Three-phase AC Voltage Controller, Drive configurations, Speed-torque characteristics, Suitability for fan-type (variable-torque) and constant-torque load applications **Stator Frequency Control** Through VSI and Cycloconverter Drives- Operation with non-sinusoidal supply – effect of harmonics -Speed-torque characteristics. **V/f Control** Through VSI Drive - Principle, mitigating the drawback of stator voltage control, Speed-torque characteristics , Constant HP and constant torque regions. **Wound Rotor IM Speed Control** - Rotor resistance control with chopper, Static Kramer, and Static Scherbius schemes		**CO2, C03**

UNIT-V	**Synchronous Motor Drives, and FOC of Induction Motor Drives**	**Periods: 9**

Synchronous Motor Drives: True Synchronous Mode Drive- Voltz/Hz speed control characteristics in torque-speed plane; Self-controlled modes of operations-IC engine analogy; Marginal angle control. **FOC in Induction Motor Drives:** Principle of vector control- DC motor analogy, Scalar versus vector control, Phasor diagram of vector controller; Direct Vector Control- Flux and torque processing through terminal voltage (Rotor flux based calculation only).	**C03, CO4**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. G. K. Dubey, *Fundamentals of Electric Drives*, Alpha Science International Ltd., 2002.
2. IS 12615: *Indian Standard Energy Efficient Induction Motors-Three Phase Squirrel Cage,* 2011.
3. P. C Sen, *Thyristor DC Drives*, Wiley-Interscience Publication, 1981.
4. G.K.Dubey*, Power Semiconductor Controlled Drives*, Prentice Hall, 1989.
5. J.M.D.Murphy and F.G.Turnbull, *Power Electronic Control of AC Motor*, Pergamon, 1990.
6. Bimal K. Bose, *Modern Power Electronics and AC Drives*, Prentice Hall, 2001.
7. R.Krishnan, Electric Motor Drives-Modelling, Analysis, and Control, Pearson, 2001.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	-	-	-	2	-	1	3	2	2
CO2	3	3	3	3	3	-	-	-	2	-	2	3	3	2
CO3	3	3	3	3	3	-	-	-	2	-	2	3	3	3
CO4	3	3	3	3	3	-	-	-	2	-	2	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC129	**Power Systems Laboratory**	-	-	3	1.5	40	60	100
Prerequisite:	Protection and Switchgear, Power System Analysis and Control Systems.							

Course Outcome: At the end of the course students will be able to		
	CO1	Understand and apply principles of electromechanical/microprocessor relays, fault analysis, and economic load dispatch for resilient power system design.
	CO2	Demonstrate and analyze transmission line parameters, Ferranti effect, and their impact on power flow stability.
	CO3	Design and evaluate transformer/motor protection schemes and integrate them with economic load dispatch strategies.
	CO4	Illustrate power flow analysis in grid systems and distributed generation, considering transmission line dynamics.
	CO5	Optimize economic load dispatch, load frequency control, and PV grid integration while addressing fault scenarios.

Any 10 Experiments	
1. Characteristics of Electromagnetic and Microprocessor Overcurrent relay. 2. Characteristics of Overvoltage and Under Voltage relay. 3. Power System Fault Analysis	**CO1, CO3**
4. ABCD parameters. 5. Identifying the location of Single phase to ground fault. 6. Computation of transmission efficiency and voltage regulation of Short, Medium, and Long transmission lines. 7. Study of Ferranti effect.	**CO2, CO4**
8. % differential protection for normal and internal faults. 9. Protection of transformer using over current and over voltage relays for external fault. 10. Motor protection using negative sequence relay for phase failure and phase reversal. 11. Motor protection using numerical relay for stall and lock. 12. Operating principles of Bucholtz relay.	**CO3, CO5**
14. Load flow analysis of grid system. 15. Distributed Generation based power flow analysis. 16. Stability based power flow analysis.	**CO4, CO2**
17. Economic load dispatch for a sample test system. 18. Load frequency control. 19. Experimental Analysis of PV Grid integration system	**CO5, CO1**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 45**	**Total Periods: 45**

Reference Books:

Laboratory Manual, Department of EEE, Puducherry Technological University, Puducherry.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	-	-	-	2	-	1	3	2	2
CO2	3	3	2	3	2	-	-	-	2	-	1	3	3	2
CO3	3	3	2	3	2	2	-	-	2	-	1	3	3	3
CO4	3	3	2	3	2	2	-	-	2	-	1	3	3	3
CO5	3	2	1	3	1	-	-	-	2	-	1	3	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC130	**Mini Project**	-	-	4	2	100	-	100
Prerequisite:								
Course Outcome At the end of the course students will be able to	**CO1**	Apply electrical and electronics engineering concepts to identify, design, and implement solutions for real-time applications in a team environment.						
	CO2	Develop and test working prototypes through simulation and/or hardware, demonstrating technical proficiency and problem-solving skills.						
	CO3	Effectively document and present project outcomes, showcasing communication skills and professional ethics.						
Students will work in a team on a topic suggested by the project guide. In this mini project work, the team of students would identify the problem taken up for the main project. They must complete the mini project with simulation or hardware and prepare a detailed report. The progress will be evaluated through at least two reviews, conducted by a project review committee in the Department. At the end of the semester, students will submit their mini project report. The final evaluation will be based on both an oral presentation and the report, assessed by the committee appointed by the Head of the Department.								**CO1, CO2, CO3**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	1	3	3	2	-	2	1	2	1	3	3	2
CO2	1	2	1	2	3	2	1	2	1	2	2	3	3	2
CO3	-	-	1	3	3	2	1	3	2	1	2	3	3	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Seventh**			Course Category Code: **PCC**			Semester Exam Type: **LB**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC131	**Comprehensive Viva**		-	-	-	1	100	-	100
Prerequisite:									
Course Outcome: At the end of the course the student will be able to	**CO1**	Demonstrate a broad understanding in the major areas of Electrical and Electronics Engineering.							
	CO2	Present innovative concepts in simple words and answering questions confidently.							
	CO3	To evaluate the student's analytical skills, logical reasoning, and problem-solving capabilities through oral questioning.							
	CO4	To develop and assess the student's ability to effectively communicate technical knowledge and ideas clearly and confidently.							
Comprehensive viva is an oral examination conducted to evaluate the critical thinking, analytical abilities, and how well a student can discuss and apply concepts learned throughout their studies. A committee comprising of five faculty members will conduct the comprehensive viva examination and evaluate the students. Experts from the industry may also be included in this committee. The Head of the Department shall constitute this committee.									**CO1, CO2, CO3, CO4**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	3	-	2	3	1	2	1	1	1
CO2	3	3	3	2	3	3	-	2	2	2	2	1	1	0
CO3	3	2	3	2	3	3	-	2	2	2	2	1	1	1
CO4	-	1	1	2	2	-	1	2	3	2	2	1	1	0

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics** Engineering			Programme: **B.Tech.**						
Semester : **Seventh**			Course Category Code: **HNC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUH104	**Design and Modelling of Renewable Energy Systems**		4	-	-	4	40	60	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	Review the perspectives of renewable energy systems and address challenges and opportunities in the renewable energy sector.							
	CO2	Develop skills in design and modelling of PV and Wind Energy systems							
	CO3	Explore the integration of renewable energy systems into existing power grids.							
	CO4	Learn the principles and practices involved in integrating different renewable energy sources using a common multiport converter							
UNIT-I	**RENEWABLE ENERGY SYSTEMS: TECHNOLOGY VERVIEW**					**Periods: 12**			
Introduction- state of the art in renewable energy - Examples of Recent Research and Development Challenges and Future Trends.									**CO1**
UNIT-II	**SINGLE-PHASE PHOTOVOLTAIC SYSTEMS**					**Periods: 12**			
Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single-phase PV Systems, Modeling of PV System Components -Solar PV array, Charge controller, battery and Inverter for standalone systems, Grid-tie inverter for grid-connected systems. System Sizing and Design: Calculating PV array size based on energy demand, Sizing batteries and charge controllers, Maximum Power Point Tracking (MPPT) MPPT concept and algorithms, DC-DC converters for MPPT. Recent converter topologies- PV module integrated DC -DC converters, benefits, Transformer less inverters- single-string inverters.									**CO2, CO3**
UNIT-III	**THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES**					**Periods: 12**			
Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- Control of PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of PLLs for Grid Synchronization, Current Control, Maximum Power Point Tracking.									**CO2, CO3**
UNIT-IV	**WIND ENERGY SYSTEMS**					**Periods: 12**			
Introduction – Generator and turbine Selection for Wind Energy Systems- Self-Excited Induction Generators - Direct Driven Permanent Magnet Synchronous Generators – D-q modelling of the Induction Generator - Comparison of different WECS- Small and micro–Wind Turbine Systems-Magnus Turbine based Wind Energy System.									**CO2, CO3**
UNIT-V	**Hybrid Energy Systems**					**Periods: 12**			
Hybrid Energy systems (HES) –conventional hybrid energy system , multi-port converter based HES , advantages–Three-port and four port converter topologies - Single DC output, Dual output and AC , DC output configurations- Applications of multiport converters in renewable energy integration, microgrids, and hybrid electric vehicles.									**CO4**
Lecture Periods: 45	**Tutorial Periods: 15**		**Practical Periods: 0**				**Total Periods: 60**		

Reference Books:

Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021

1. Nabil Derbel, Quanmin ZhuModeling, "Identification and Control Methods in Renewable Energy
2. Systems", Springer, First Edition, 2019
3. Generalized Theory of Electrical Machines by P.S. Bimbhra, Khanna Book Publishing Co. P Ltd,2021
4. Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression.
5. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.
6. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.
7. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.

8. Analysis of Electric Machinery and Drive Systems" by Paul C. Krause, Wiley–Blackwell,2002

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	-	3	3	2	3	3	2	2
CO2	2	3	3	3	3	2	-	3	3	2	3	2	3	3
CO3	3	3	2	3	2	2	-	3	3	1	3	3	2	3
CO4	3	3	3	3	3	2	-	2	2	2	2	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Eighth**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC132	**Project Work**	-	-	16	8	60	40	100
Prerequisite:								

Course Outcome At the end of the course students will be able to	**CO1**	Apply domain specific knowledge and engineering principles to analyze, simulate, and/or develop hardware solutions for real-world problems.
	CO2	Demonstrate the ability to critically evaluate and validate project outcomes through comparative analysis with simulation/hardware results or existing methodologies reported in literature.
	CO3	Communicate effectively project findings through technical presentations and publications in national/international conferences, symposiums, or referred journals.

In this project work, the team would solve the problem taken up for study. Simulation studies and/or hardware development would be completed and the hardware results will be compared with the simulation results to validate the effectiveness of the developed set up. Necessary inferences have to be drawn from the studies carried out and the same should be presented before the committee members. If the project involves intensive analytical procedure, the analysis has to be completed and suitable comparison to existing methodologies reported in literature should be done to validate the correctness as well as effectiveness of the work. Rigorous review by the committee will be carried out in the process to ascertain whether the work qualifies as a suitable project at the graduate level. Each team is expected to present their work at National/International conferences or at the students' technical symposiums. Team that has come out with novel contribution will be encouraged to publish their work in any referred journals.	**CO1, CO2, CO3**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	2	-	2	1	2	1	3	3	3
CO2	2	2	1	2	3	2	1	2	1	2	2	3	3	3
CO3	1	1	1	3	3	2	1	3	2	1	2	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Eighth**			Course Category Code: **HNC**				Semester Exam Type: **LB**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUH105	**Seminar**		-	-	4	2	100	-	100
Prerequisite:									
Course Outcome The Student will be able to	**CO1**	Investigate and comprehend advanced and emerging topics in Electrical and Electronics Engineering through literature review and self-directed learning.							
	CO2	Enhance proficiency in technical presentations, academic writing, and the clear communication of complex engineering concepts.							
	CO3	Demonstrate the ability to work independently, manage time effectively, and fulfill academic and professional responsibilities in a formal setting.							
Each student is required to deliver a seminar presentation on a topic related to an emerging area in electrical & electronics engineering discipline. The presentation should be atleast 20 minutes. In addition to the oral presentation, students must submit a brief written report on the seminar topic. The report should be 15 to 20 pages in length and will be used for evaluation purposes. Upon completion, a Seminar report must be submitted for evaluation. A departmental committee shall evaluate the performance of the students.									**CO1, CO2, CO3**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	-	3	2	2	1	3	3	2
CO2	3	2	2	2	2	2	1	3	2	2	2	3	3	2
CO3	3	2	2	2	2	2	1	3	3	2	2	3	3	2

Score: 3 – High; 2 – Medium; 1 – Low

Annexure II

Syllabus of B. Tech. (Electrical and Electronics Engineering)
Programme Elective Courses

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	**Course Name**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE101	**Fuzzy Logic and Neural Networks**	3	1	-	4	40	60	100
Prerequisite:								

Course Outcome: At the end of the course students will be able to		
	CO1	Explore the fundamental concepts of Fuzzy set theory and Mathematics
	CO2	Introduce the Fuzzy inference mechanisms and defuzzification concepts
	CO3	Familiarize the fundamental concepts of Neural Networks
	CO4	Explore the concepts of supervised and unsupervised learning algorithms used in Neural Networks
	CO5	Acquire knowledge of associative memories and Neuro Fuzzy Systems and its applications to Engineering

UNIT-I	**Fundamental Concepts of Fuzzy Set Theory**	**Periods: 12**
Conventional sets versus fuzzy sets – Basic concepts and definitions. Operation in fuzzy sets– NOT, AND and OR operators. Convexity of fuzzy sets-lamda cuts on fuzzy sets. Membership functions -type's choice and membership value assignment methods.		**CO1, CO2**
UNIT-II	**Fuzzy Inference Mechanisms**	**Periods: 12**
Fuzzy relationship –equivalence and tolerance. Fuzzy if then rules– types. Rule based models - Mamdani and TSK models. Defuzzification methods. Fuzzy control systems– Simple and general controllers– applications		**CO2**
UNIT-III	**Introduction to Neural Networks**	**Periods: 12**
Biological neuron- comparison between a biological neuron and a computer- Model of an Artificial Neuron –single and multi-input neurons. Transfer functions-types. Neural Network Architectures Perceptron learning rule- limitations -linear seperability problem. Multilayer networks.		**CO3, CO4**
UNIT-IV	**Supervised and unsupervised learning algorithms**	**Periods: 12**
Optimization techniques. Back propagation algorithm for multi-layer networks– advantages, drawbacks and applications – Variants of Back Propagation Algorithms. RBF networks. Hebbs unsupervised learning rule. Kohonens self-organizing map algorithm		**CO4**
UNIT-V	**Associative memories and Neuro Fuzzy Systems**	**Periods: 12**
Types of Associative Memories –Bidirectional Associative Memories – Auto Associative Memory: Architecture, Algorithm and properties. Neuro-fuzzy systems– Application of neural and fuzzy systems to Engineering.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. Timothy. J. Rose, Fuzzy logic with Engineering applications, McGraw Hill, 2012.
2. John Yen, Reza Langani, Fuzzy logic, Pearson Education, 2010.
3. S. Rajasekaran, G. A. VijayalakshmiPai, Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, PHI, 2024.
4. K. Vinoth Kumar, R. Saravana Kumar, Neural Networks and Fuzzy Logic, Katson, 2022.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	-	-	1	2	-	2	3	2	1
CO2	3	3	3	2	2	2	-	-	2	-	2	1	2	1
CO3	2	2	3	3	1	2	-	1	1	-	1	1	1	1
CO4	-	3	3	2	2	3	-	-	1	-	1	2	1	1
CO5	1	3	2	3	2	2	-	-	1	-	1	1	1	1

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE102	**Digital Signal Processing**	3	1	-	4	40	60	100
Prerequisite:	Transforms and Partial Differential Equations							
Course Outcome At the end of the course, the students will be able to	**CO1**	Explain the concepts of digital signals and digital systems.						
	CO2	Use z transform, DFT and FFT techniques						
	CO3	Design FIR and IIR digital filters and implement them in different forms.						
	CO4	Analyze the errors due to discretization in digital filters						
UNIT-I	**Discrete Time Signals And Systems**				**Periods: 12**			
Basic elements of signal processing-Sampling of analog signals–aliasing–standard discrete time signals - classification of discrete time signals-manipulations on discrete time signals- representation of discrete time signals. Discrete time systems-properties-Linear Time Invariant systems-convolution sum-properties of LTI systems-difference equation representation.								**CO1**
UNIT-II	**Discrete Time System Analysis**				**Periods: 12**			
Z-transform–region of convergence – properties of z-transforms- inverse z-transform-difference equation– solution by z-transform- application to discrete systems-interpretation of stability in z domain - stability analysis- convolution-linear and circular.								**CO1, CO2**
UNIT-III	**DFT and FFT**				**Periods: 12**			
Discrete Fourier Transform-properties - relationship between z- transform and DFT-Frequency analysis of signal using DFT. FFT algorithms-advantages over discrete computation of DFT –radix2 algorithms-Decimation In Time-Decimation In Frequency-Computation of IDFT using FFT.								**CO2**
UNIT-IV	**Design of Digital Filters**				**Periods: 12**			
FIR filter design-linear phase FIR filters- Fourier series method-windowing techniques–frequency Sampling techniques. IIR filter design- analog filter design-Butterworth and Chebyshev approximations-digital filter design using impulse invariant technique and bilinear transformation method -warping, pre warping-Frequency transformation.								**CO3**
UNIT-V	**Filter Implementation and Finite Word Length Effects**				**Periods: 12**			
Structures for FIR systems-direct form, cascade and linear phase structures-structures for IIR systems-direct form, parallel, cascade and ladder structures- Representation of numbers-errors resulting in rounding and truncation quantization of filter coefficients-round off effects in digital filter–product quantization error, overflow limit cycle oscillations								**CO3, CO4**
Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**			**Total Periods: 60**			

Reference Books:

1. John G. Proakis and Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, PHI Learning, New Delhi, Fourth Edition, 2008.
2. Alan V. Oppenheim and W. Schafer, “Discrete Time Signal Processing”, Prentice Hall of India Pvt. Ltd., 2001
3. Rabiner and Gold, “Theory and Applications of Digital Signal Processing”, Prentice Hall of India Pvt. Ltd., 2001.
4. SanjitK.Mitra, “Digital Signal Processing: A Computer Based Approach”, Tata McGraw–Hill, Third Edition, 2005.
5
5. P. Ramesh Babu, “Digital Signal Processing”, Scitech Publications, Fourth Edition, 2007.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	2	-	-	-	-	-	-	-	2	-	-
CO2	2	2	2	3	-	-	-	-	-	-	1	2	-	-
CO3	3	3	2	3	-	-	-	-	-	-	2	2	2	2
CO4	2	2	2	3	-	-	-	-	-	-	2	2	-	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Fifth**			Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	**Course Name**		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUE103	**Modern Control Theory**		3	1	-	4	40	60	100
Prerequisite:	Control Systems								
Course Outcome At the end of the course, the students will be able to	**CO1**	Apply the philosophy of modelling of dynamical systems in state-space and to study varied forms of mathematical model of dynamic systems.							
	CO2	Solve state equation and to evaluate the evolution of the system subjected to mathematically quantified input with non-zero initial conditions.							
	CO3	Interpret the significance of various attributes of a dynamical system like stability, controllability, observability, stabilizability and detectability.							
	CO4	Design state-feedback controllers for stabilization of unstable or poorly stable system with directly available state variable measurements.							
	CO5	Synthesize observer based state-feedback controllers for system with inaccessible (unmeasurable) state variables and to design optimal state feedback controller for LTI systems using LQR approach.							

UNIT-I	**State-space Modelling of Dynamical Systems**	**Periods: 12**
Modelling of physical systems using state-space approach – advantages of state-space approach over transfer function approach. State-space model using physical variable approach for SISO and MIMO systems – phase variable approach based state-space modelling for SISO systems. Development of linear state-space models for nonlinear systems using Taylor series approach. State diagram, state space and state-trajectory. Canonical forms of state-space models for SISO LTI system: controllable, observable canonical forms and diagonal/Jordan's diagonal canonical forms – realization schematic. Similarity transformation of a given system into different canonical forms.		**CO1, CO3**
UNIT-II	**Analysis of Dynamical Systems**	**Periods: 12**
Solution of LTI state-equation – state-transition matrix – properties of state transition matrix - computational techniques of state transition matrix (Laplace transform technique and infinite series method and similarity transformation approach). Computation of state transition matrix using Caley-Hamilton Theorem and Sylvester interpolation formula.		**CO1, CO2**
UNIT-III	**Attributes of Dynamical Systems and Stability Analysis**	**Periods: 12**
Controllability and Observability – Tests (Kalman's test and Popov-Belavich-Hautus test) – Duality property – stabilizability and detectability properties. Equilibrium point of linear and nonlinear systems – Internal and BIBO stability. Nonlinear state-space equations and Stability of nonlinear systems *in the sense of Lyapunov* - Lyapunov and Krasovskii stability theorems. Lyapunov stability criterion for LTI systems (including LTI affine systems as well). Parametric optimization using quadratic cost function for LTI systems.		**CO1, CO3**
UNIT-IV	**Synthesis of State Feedback Controller**	**Periods: 12**
State-feedback control design: Introduction – relationship between pole location in s plane and system performance – control specifications – choice of desired closed loop poles based on dominant pole pair approach from controller specifications – set-point tracking and disturbance rejection problems. State feedback control – necessary and sufficient condition – computational techniques of state-feedback gain matrix (direct substitution, using similarity transformation and Ackermann's formula).		**CO1, CO3, CO4**
UNIT-V	**Synthesis of Observer based State Feedback Controller and Optimal Controller Design**	**Periods: 12**

State estimation – Observer design - necessary and sufficient condition – computational techniques of observer gain matrix (direct substitution, using similarity transformation and Ackermann's formula) – Observer-based state-feedback control – separation principle - minimum order observer. Design of Servo systems – State-feedback control with integral error compensation. Optimal control: design of optimal state feedback control using LQR approach. Use of AI techniques for state feedback controller synthesis.	**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall, 2010.
2. I J Nagrath and M. Gopal, "Control Systems Engineering", New Age International (P) Limited, 2008.
3. Norman S Nise, "Control Systems Engineering", 7th Edition, Wiley, 2015.
4. Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", 8th Edition, Pearson, 2018.
5. Biswa Nath Datta, "Numerical Methods for Linear Control Systems: Design and Analysis", Elsevier, 2004.
6. John S Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill Series in Electrical Engineering, 1998.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	1	-	-	-	-	-	-	3	2	1
CO2	3	3	2	2	2	-	-	-	-	-	-	3	2	1
CO3	2	3	2	3	2	-	-	-	-	-	-	3	2	1
CO4	3	3	2	3	1	-	-	1	1	-	-	3	2	1
CO5	3	3	2	3	1	-	-	1	1	-	-	3	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE104	**Special Electrical Machines**	3	1	-	4	40	60	100
Prerequisite:	DC Machines and Transformers, AC Machines							

Course Outcome: At the end of the course, the students will be able to		
	CO1	Know the basic concepts of various types of Single-phase machines
	CO2	Gain knowledge about the principle and construction of stepper motor and its types.
	CO3	Analyse the principle & working of switched reluctance motor.
	CO4	Acquire knowledge on the working principle of permanent magnet brushless dc motor.
	CO5	Gain knowledge of working principle of permanent magnet synchronous motor and DFIG

UNIT-I	**Single Phase Machines**	**Periods: 12**
Principle and construction of split phase motors - Shaded Pole motor - Repulsion motor – Universal motor – unexcited synchronous single-phase motor – AC and DC Servo motor – Linear Induction Motor – Applications.		**CO1**
UNIT-II	**Stepper Motor**	**Periods: 12**
Constructional features-principle of operation-Types of motors– Modes of operation–Drive system and circuit control of Stepper motor –Static and Dynamic Characteristics and Applications.		**CO2** **CO3**
UNIT-III	**Switched Reluctance Motor**	**Periods: 12**
Constructional details-principles of operation- Torque production–drive circuits–Current regulation– Torque speed characteristics– Speed and torque control– Static observers for rotor position sensing– volt- ampere requirements– Applications		**CO2** **CO3**
UNIT-IV	**Permanent Magnet Brushless DC Motor**	**Periods: 12**
Commutation in DC motors– Difference between mechanical and electronic commutators– Principle of operation- Construction–drive circuits–Torque and emf equation– Torque and Speed characteristics– sensors and sensor less systems– controllers and applications.		**CO4** **CO5**
UNIT-V	**Permanent Magnet Synchronous Motor**	**Periods: 12**
Principles of operation–Constructional features– Phasor diagram–torque speed characteristics –torque and emf equations–vector controllers- applications. Doubly Fed Induction Generator–Principle – construction, characteristics and applications.		**CO4** **CO5**

Lecture Periods: 45	**Tutorial Periods:15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1.Venkataratnam K, Special Electrical Machines, Universities Press, Hyderabad,3rd Edition 2009.
2. P.P.Acarnley, Stepping Motors, A Guide to Modern theory and practice, Peter Peregrines, London, 2002.
3. A.Hughes, Electric Motors and Drives, Affiliated East-West Press Pvt., Ltd., 2007
4. R.Krishnan, Electric Motor Drives Modeling, Analysis, and Control, Prentice Hall of India
5. R.K.Rajput, Electrical Machines, Laxmi Publications, New Delhi, 2009
6. K.Dhayalini, Special Electrical Machines, Anuradha Publications 2007.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	2	-	-	-	-	1	2	2	1
CO2	2	3	2	2	2	2	-	-	-	-	1	2	2	1
CO3	2	3	2	2	2	2	-	-	-	-	1	2	2	1
CO4	2	3	2	2	2	2	-	-	-	-	1	2	2	1
CO5	2	3	2	2	2	2	-	-	-	-	1	2	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE105	**Power Generation Systems**	3	1	-	4	40	60	100
Prerequisite:								

Course Outcome: At the end of the course, the students will be able to		
	CO1	Know the concepts of power generation from various conventional and non-conventional power generation methods.
	CO2	Gain understanding of different types of power plant, and its functions and their flow lines and issues related to them.
	CO3	Acquire exposure in the economic operation of power generating stations
	CO4	Analyse and solve energy and economic related issues in power sectors.
	CO5	Understand the concept of non-conventional power plants

UNIT-I	**Economics of Generation**	**Periods: 12**
Load and load duration curve – load, demand and diversity factors – plant capacity and plant use factors – choice of type of generation – choice of size and number of units – cost of energy generated – tariffs.		**CO1 CO2**
UNIT-II	**Thermal And Hydro Power Systems**	**Periods: 12**
Comparison of power systems – classification, typical layout and working of steam, diesel low and high head hydro power plants–pumped storage plants.		**CO1 CO2**
UNIT-III	**Economic Operation of Steam – Hydro Plants**	**Periods:12**
Interconnected operation – division of load in interconnected systems – loss formula coefficients – economic loading of steam power plants and steam hydro power plants.		**CO1 CO2 CO3**
UNIT-IV	**Nuclear Power Plants**	**Periods: 12**
Principle of nuclear power generation – location – advantages and disadvantages of nuclear power plants – types of nuclear reactors and their comparison –Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR)– layout of reactors – reactor control – reactor safety – waste disposal-Safety measures for Nuclear Power plants.		**CO2 CO4**
UNIT-V	**Non-Conventional Power Plants**	**Periods: 12**
Basic concepts – principle of working and layout of MHD, solar, wind, tidal, biomass, geothermal power Generation and Fuel Cell power systems.		**CO1 CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. V.K Mehta, "Principles of Power Systems", S. Chand & Company Ltd., New Delhi., 2012.
2. 2. M. L. Soni, P. V. Gupta, U. S. Bhatnagar, "A Course in Electrical Power", Edition9, Dhanpat Rai, 1987
3. 3. Nag.P.K. K, "Power Plant Engineering", Tata McGraw Hill, Second Edition, 12th Reprint, 2006.
4. 4. Rai. G.D, "An introduction to Power Plant Technology", Khanna Publishers, Delhi, Eleventh Reprint,2013.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	3	-	1	1	2	1	2	1	2
CO2	2	1	1	1	1	3	-	1	1	-	-	2	1	-
CO3	2	1	1	1	1	3	-	1	1	-	-	2	1	2
CO4	2	1	1	1	1	3	-	1	1	-	-	2	1	-
CO5	2	1	1	1	1	3	-	1	1	-	-	2	1	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	**Course Name**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE106	**Digital Control Systems**	3	1	-	4	40	60	100
Prerequisite:	Control Systems, Modern Control Theory, Signals and Systems							

Course Outcome At the end of the course, the students will be able to		
	CO1	To identify the basic concepts of digital control system and to compute appropriate sampling time for the reconstruction of continuous-time signal from the sampled data of the same, and to subsequently interpret and evaluate the z transformation technique involved in the analysis of digital control systems.
	CO2	To use the concept of convolution summation involved in the derivation of pulse transfer function of the digital control system and to study the techniques involved in ascertaining of stability of digital control system.
	CO3	To discuss the classical (transfer function based) techniques involved in the synthesis of controllers for digital control system.
	CO4	To develop state space model for digital control systems and to comprehend the important properties of such models.
	CO5	To synthesis state feedback controllers using arbitrary pole placement and optimal control techniques to stabilize unstable and poorly stable systems, and to subsequently evaluate the methods to stabilize discrete-time systems using state feedback control with corrupted state variable measurements.

UNIT-I	**Introduction to Digital Control Systems**	**Periods: 12**
Introduction to Digital Control Systems – Sub-systems of a typical digital control systems – sampling of continuous-time signal – Quantization procedure and quantization error. Impulse sampling technique. Data hold technique – zero order hold circuit. ADC and DAC techniques and circuits. Z transform – z transform of elementary signals – z-transform properties – important theorems of z-transform – inverse of z transform. Mapping between z-plane and s-plane. Reconstruction of continuous-time signal from sampled signal – Shannon's sampling theorem.		**CO1**
UNIT-II	**Analysis of Digital Control Systems**	**Periods: 12**
Convolution summation – starred Laplace transform – open loop and closed-loop pulse transfer functions. Stability analysis of closed-loop discrete-time control systems using Jury's stability test and Bilinear transformation technique. Transient and steady state analysis of discrete-time control system using step signal.		**CO1, CO2**
UNIT-III	**Design of Output Feedback Controller**	**Periods: 12**
Correlation between the location of poles in z-plane and time response – design of digital controller in z-plane (using root locus approach) and w-plane (frequency response approach) – Integer order PID controllers – P/I/D control actions – Classical tuning technique for PI/PID controllers – discretization of continuous-time PID controller – digital electronic circuit based realization diagrams.		**CO1, CO3**
UNIT-IV	**State-space Modelling/Analysis of Digital Control System**	**Periods: 12**
State-space model of discrete-time system – discretization of continuous-time state-space models – solution to state equation. State transition matrix – its importance and properties. Derivation of pulse transfer function from state-space models – characteristic equation – system poles and stability. Eigen values (and its significance to stability) and Eigen vectors – Similarity transformation – Diagonal realization forms. Controllability and Observability properties. Stability analysis using Lyapunov technique.		**CO1, CO4**
UNIT-V	**Design of State Feedback Controller**	**Periods: 12**

State feedback controller design using arbitrary pole placement technique – necessary and sufficient conditions for arbitrary pole placement in z-plane – controller synthesis techniques: direct substitution technique, similarity transformation technique and Ackermaan's formula – Deadbeat control. Optimal state feedback control design using discrete-time LQR approach. Observer design and synthesis of observer based state feedback controller.	**CO1, CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. Katsuhiko Ogata, "Discrete-Time Control Systems", Second Edition, Prentice Hall India Learning Private Limited, 2005.
2. M. Sami Fidali and Antonio Visioli, "Digital Control Engineering: Analysis and Design", Elsevier Inc., 2009.
3. Charles L Phillips and H. Troy Nagle, "Digital Control Systems: Analysis and Design", Pearson Education International, 1998.
4. Gene F. Franklin, J. David Powell and Michael Workman, "Digital Control of Dynamic Systems", 8th Edition, Pearson, 2018.
5. Kannan Moudgaliya, "Digital Control", John Wiley & Sons Ltd, 2007.
6. Allen R. Stubberud, Gene H. Hostetter, Mohammed S. Santina, "Digital Control System Design", Oxford University Pressm 1994.
7. M. Gopal, "Digital Control and State Variable Methods", McGraw Hill Education, 4th Edition, 2017.
8. Benjamin C. Kuo, "Digital Control Systems", Saunders College Publishing, 1992.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	-	-	-	-	3	2	1
CO2	3	3	1	2	3	-	-	-	-	-	-	3	2	1
CO3	3	3	3	3	3	-	-	-	-	-	-	3	2	1
CO4	3	3	2	2	2	-	-	-	-	-	-	3	2	1
CO5	3	3	3	3	3	-	-	-	-	-	-	3	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE107	**Electric and Hybrid Vehicles**	3	1	-	4	40	60	100
Prerequisite:	DC Machines and Transformers, AC Machines, Power Electronics, Control Systems.							
Course Outcome: At the end of the course, the students will be able to	**CO1**	Understand the fundamental concepts of hybrid and electric vehicles, including their social and environmental impacts.						
	CO2	Analyze and compare different hybrid powertrain architectures (series, parallel, series-parallel) and their working principles.						
	CO3	Evaluate battery technologies, energy storage systems, and charging infrastructure for hybrid and electric vehicles.						
	CO4	Design and analyze power electronics, motor drive systems, and control strategies in HEVs						
	CO5	Explore recent advancements, smart grid integration, and case studies in hybrid/electric vehicle technology.						

UNIT-I	**Introduction to Electric Vehicles (EV) & Hybrid Vehicles (HV)**	**Periods: 12**
A brief history of Electric and Hybrid Vehicles, basic architecture of hybrid drivetrains. Social and Environmental impact of electric and hybrid vehicle technology. Fundamentals of Vehicle propulsion and braking - dynamic equations for vehicles, Vehicle Power Plant and Transmission Characteristics-Vehicle Performance.		**CO1, CO5**
UNIT-II	**Powertrain Architectures and Energy Sources**	**Periods: 12**
Classification of hybrid and electric vehicle powertrains—series, parallel, and series-parallel configurations. Plug-in hybrid and range-extender vehicles, role of the internal combustion engine in hybrid systems, and integration of alternative power sources. Energy storage technologies including batteries, ultracapacitors, and fuel cells.		**CO2, CO3**
UNIT-III	**Battery Technology and Energy Management**	**Periods: 12**
Energy storage requirements in electric and hybrid vehicles, key parameters of battery performance, and different types of batteries used in EVs (Lead Acid, Nickel-based, Lithium-ion, Metal-Air). Battery management systems (BMS) and thermal management strategies for improving battery life and efficiency. Charging technologies including slow, fast, charging methods, onboard and offboard charging infrastructure.		**CO3, CO4**
UNIT-IV	**Power Electronics and Motor Drive Systems**	**Periods: 12**
Introduction to power electronics in electric and hybrid vehicles. Power converters used in EVs, including DC-DC converters, inverters, and rectifiers. Motor drive technologies—DC motor drives, Induction motor drives, Permanent Magnet motor drives, and Switched Reluctance motor drives. Control strategies for electric propulsion,		**CO4, CO2**
UNIT-V	**Recent Trends and Case Studies**	**Periods: 12**
Recent advancements in hybrid and electric vehicle technologies, and smart grid integration for EVs. Environmental and economic impacts of widespread EV adoption. Future trends in EV and HV development, including solid-state batteries, vehicle-to-grid (V2G) and grid to vehicle (G2V) technology. Case studies of commercial hybrid and electric vehicles.		**CO5, CO1**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals”, 2nd Edition, CRC Press, 2010.
2. James Larminie, John Lowry “Electric Vehicle Technology Explained”, 1st Edition, John Wiley and Sons, 2003.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, Wiley publication,2011.
4. Allen Fuhs, “Hybrid Vehicles and the future of personal transportation”, CRC Press, 2009.
5. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybridand Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	2	-	-	2	-	1	3	2	2
CO2	3	3	2	3	2	-	-	-	2	-	1	3	3	2
CO3	3	3	2	3	2	2	-	-	2	-	1	3	3	3
CO4	3	3	2	3	2	2	-	-	2	-	1	3	3	3
CO5	3	2	2	3	1	3	-	-	2	1	1	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE108	**Electrical Safety and Quality Management**	3	1	-	4	40	60	100
Prerequisite:								
Course Outcome: At the end of the course students will be able to	**CO1**	Understand the IE rules and its significance.						
	CO2	Understand the electrical safety in residential, commercial and agricultural installations.						
	CO3	Know about the electrical safety during installation, testing and commissioning, operation and maintenance.						
	CO4	Know more about electrical safety in hazardous areas.						
	CO5	Gain knowledge about quality management.						
UNIT-I	**Review of IE Rules and Acts and Their Significance**				**Periods: 12**			
Objective and scope – Ground clearances and section clearances – Standards on electrical safety - Safe limits of current, voltage - Earthing of system neutral – Rules regarding first aid and fire fighting facility.								**CO1, CO2**
UNIT-II	**Electrical Safety in Residential, Commercial and Agricultural Installations**				**Periods: 12**			
Wiring and fitting – Domestic appliances – Water tap giving shock – Shock from wet wall – Fan Firing shock –Multi-storeyed building – Temporary installations –Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.								**CO1, CO2**
UNIT-III	**Safety During Installation, Testing and Commissioning, Operation and Maintenance**				**Periods: 12**			
Preliminary preparations – safe sequence – Risk of plant and equipment – Safety documentation – Field quality and safety - Personal protective equipment – Safety clearance notice – Safety precautions – Safe guards for operators Safety								**CO1, CO3, CO5**
UNIT-IV	**Electrical Safety in Hazardous Areas**				**Periods: 12**			
Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment's for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – Classification of equipment/enclosure for hazardous locations.								**CO4, CO5**
UNIT-V	**Quality Management**				**Periods: 12**			
Total quality control and management – Importance of high load factor – Disadvantages of low power factor – Causes of low P.F. – Power factor improvement – Equipment – Importance of P.F. improvement.								**CO1, CO5**
Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**			**Total Periods: 60**			

Reference Books:

1. S. Rao, R.K.Jain, H.L. Saluja, Electrical Safety, Fire Safety Engineering and Safety Management, Khanna Publishers, New Delhi, 1997.
2. Al Winfield, Mary Capelli-Schellpfeffer and Dennis Neitzel, Electrical Safety Hand Book, McGraw Hill Publications, 2018.
3. Martha J. Boss, Gayle Nicoll, Electrical Safety: Systems, Sustainability, and Stewardship, CRC Press, 2014.
4. Peter E. Sutherland, Principles of Electrical Safety, IEEE Press, Wiley, 2025.
5. W. Fordham-Cooper, Electrical Safety Engineering, Newnes, 2002.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	3	2	1	2	-	1	2	-	-	-
CO2	2	3	3	3	3	3	3	1	2	-	1	2	-	-	-
CO3	2	3	3	3	3	3	3	1	2	-	1	2	-	-	-
CO4	2	3	3	3	3	3	3	1	2	-	1	2	-	-	-
CO5	3	3	3	3	3	2	2	1	2	-	1	3	-	-	-

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PEC**			Semester Exam Type: **TY**			
Course Code	Course	Periods / week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE109	**Renewable Energy**	3	1	-	4	40	60	100
Prerequisite								

Course Outcome: At the end of the course students will be able to	**CO1**	Acquire knowledge about various conventional and renewable energy sources, current trends and their environmental impacts.
	CO2	To provide students with a deep understanding of the principles, technologies, and applications of solar and wind energy conversion systems.
	CO3	Able to understand the Biomass, Geothermal and Ocean energy power plants and explore its application for sustainable energy solutions
	CO4	To equip students with the knowledge and skills needed to work in the growing field of hybrid energy systems, which play a critical role in the global transition to sustainable

UNIT-I	**General Aspects**	**Periods: 12**
Fundamentals of energy- Classification of energy resources, Energy Reserves of India, consumption trend. Importance of non-conventional energy sources- Concept of new and renewable energy systems - World energy status- Indian energy scenario - government policies on renewable energy adoption -Energy conservation and its importance- Environmental aspects of electricity generation - Need for energy storage – Types of Energy storage systems.		**CO1**
UNIT-II	**Solar Energy**	**Periods: 12**
Fundamentals of solar energy- solar radiation spectrum, Solar constant, solar radiation measurement. Solar thermal systems- Principle and types of solar collectors, Solar water heater, Solar refrigeration and air-conditioning systems. Solar Photovoltaic Systems- Solar cell, power characteristics, PV module, panel and array construction, Maximizing the power output, Grid-connected solar PV power plant, Stand-alone systems-applications.		**CO2**
UNIT-III	**Wind Energy**	**Periods: 12**
Nature and characteristics of wind - Power available in the wind - Horizontal and vertical axis wind turbines - Yaw and Pitch Control – Power characteristics of wind turbines- Generators for wind energy conversion systems - Fixed and variable operation – On-grid and off-grid systems- site selection - wind farm - Environmental aspects.		**CO3**
UNIT-IV	**Biomass, Geothermal and Ocean Energy**	**Periods: 12**
Bio-mass resources -biomass conversion technologies, Biomass gasification , Biogas plants - Geothermal energy - origin and distribution of geothermal energy, types of geothermal resources, principle of working geothermal power plants ,Energy from tides and waves - working of tidal power plants, wave energy Generation, OTEC power plant.		**CO4**
UNIT-V	**Hybrid Energy Systems**	**Periods: 12**
Introduction-Need for Hybrid Systems – Types – PV hybrid with diesel generator – Biomass hybrid with diesel generator – Wind-PV hybrid system – Micro Hydel-PV hybrid system- Microgrid system using renewable energy sources - Case studies: Community-based renewable projects, Biogas-solar thermal hybrid system, Wind-PV-Battery hybrid system.		**CO5**

Lecture Periods: 45	**Tutorial Periods:15**	**Practical Periods: 0**	**Total Periods:60**

Reference Books:

1. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 2003.
2. D.P. Kothari, K.C. Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learning Private Limited, New Delhi,3rd edition, 2021
3. Khan B H, “Non-Conventional Energy Resources”, Tata McGraw-Hill, New Delhi 2017
4. Mukund R Patel, “Wind and Solar Power Systems”, CRC Press, New York, 2011.
5. Solanki, Chetan Singh, " Solar Photovoltaics - Fundamentals, Technologies and Applications", PHI, New Delhi, 2015.
6. Bhadra S N, Banerjee S, Kastha D, “Wind Electrical Systems”, Oxford University Press, New Delhi, 2008
7. Roger A. Messenger, "Photovoltaic Systems Engineering", CRC Press, New York, 2010.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2	2	-	2	-	2	3	-	3	3	2	3
CO2	3	3	3	3	3	2	-	3	2	-	2	3	3	3
CO3	3	1	2	1	2	2	-	3	2	-	2	3	3	3
CO4	3	3	3	3	3	2	-	2	2	-	2	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE110	**Utilization of Electrical Energy**	3	1	-	4	40	60	100
Prerequisite:	Electric Circuit Analysis, DC Machines and Transformers, AC Machines							

Course Outcome: At the end of the course students will be able to		
	CO1	Acquire the knowledge of different ways of illumination and energy saving concepts
	CO2	Explore the types of electric heating, electric welding and design a heating element
	CO3	Study the characteristics of different types of motors and learn the electrical and mechanical features for suitable application.
	CO4	Analyse the different electric traction systems and address the recent trends.
	CO5	Understand the different types of batteries and energy conservation

UNIT-I	**Illumination**	**Periods: 12**
Introduction - definition and meaning of terms used in illumination engineering –Laws of illumination - classification of light sources - sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED.		**CO1**
UNIT-II	**Heating and Welding**	**Periods: 12**
Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding - radiation welding.		**CO2**
UNIT-III	**Electric Drives and Control**	**Periods: 12**
Group drive – Individual drive – selection of motors – starting and running characteristics – Mechanical features of electric motors – Drives for different industrial applications - Choice of drives – power requirement calculation – power factor improvement.		**CO3**
UNIT-IV	**Electric Traction**	**Periods: 12**
Traction system – Speed time characteristics – Series and parallel control of D.C motors - Open circuited, shunt and bridge transitions – Tractive effort calculation – Electric braking – Tramways and trolley bus – A.C traction and recent trend.		**CO3, CO4**
UNIT-V	**Electrolytic Processes**	**Periods: 12**
Electrolysis – polarization factor – preparation work for Electro plating – Tanks and other equipment – Calculation of energy requirements – Methods of charging and maintenance – Ni-iron and Ni- cadmium batteries -Components and materials. Energy Auditing – Energy Conservation techniques for domestic and industrial applications.		**CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. N.V. Suryanarayana, “Utilisation of Electric Power”, New Age International Limited, 2014.
2. J.B. Gupta, “Utilisation Electric power and Electric Traction”, S.K. Kataria and sons, 2000.
3. R.K. Rajput, “Utilisation of Electric Power”, Laxmi publications private Limited., 2016.
4. H. Partab, “Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Co., New Delhi-2014.
5. C.L. Wadhwa, “Generation, Distribution and Utilisation of Electrical Energy”, New Age international Pvt. Ltd., 2007.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	-	-	-	-	-	2	1	2
CO2	2	2	2	3	3	3	-	-	-	-	-	2	1	2
CO3	3	2	3	3	2	3	-	-	-	-	-	1	1	2
CO4	3	3	2	3	2	3	-	-	-	-	-	2	1	2
CO5	3	2	2	3	3	3	-	-	-	-	-	2	1	2

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE111	**Distributed Generation**	3	1	-	4	40	60	100
Prerequisite:	Power System Analysis, Renewable Energy, DC Machines and Transformers, AC Machines.							
Course Outcome: At the end of the course students will be able to	**CO1**	Explain the fundamentals, benefits, and policy frameworks of distributed generation (DG) systems.						
	CO2	Analyze renewable energy technologies and their integration methods into DG systems.						
	CO3	Evaluate economic viability and planning strategies for DG deployment, including microgrids.						
	CO4	Assess power quality issues, protection schemes, and reliability metrics in DG networks.						
	CO5	Investigate smart grid technologies, emerging trends (V2G, blockchain), and case studies in DG.						
UNIT-I	**Introduction to Distributed Generation**				**Periods: 12**			
Concept of distributed generation, comparison with centralized generation, need for distributed generation in modern power systems, benefits of DG—economic, environmental, and reliability improvements. Types of distributed generation systems, grid-connected and standalone DG systems, impact of DG on power system operation and planning. Regulatory and policy frameworks governing DG adoption.								**CO1, CO3**
UNIT-II	**Renewable Energy Sources for Distributed Generation**				**Periods: 12**			
Introduction to renewable energy sources—solar PV, wind energy, biomass, small hydro, and fuel cells. Characteristics and power generation potential of each source. Hybrid energy systems and their role in distributed generation. Power electronic interfaces for integrating renewable energy with the grid. Energy storage technologies in DG, including batteries, ultracapacitors, and flywheels.								**CO2, CO4**
UNIT-III	**Technical and Economic Aspects of Distributed Generation**				**Periods: 12**			
DG planning and site selection criteria, sizing of DG units, and economic analysis of DG deployment. Cost-benefit analysis, payback period, and financial incentives for DG projects. Microgrids and their operation in distributed generation systems. Demand-side management and its role in optimizing DG operation. Energy pricing models and tariff structures for DG-based power systems.								**CO3, CO5**
UNIT-IV	**Power Quality, Reliability, and Protection in DG**				**Periods: 12**			
Power quality issues in DG systems—voltage regulation, harmonics, and reactive power management. Impact of DG on system stability and network security. Protection challenges in DG systems, islanding detection techniques, anti-islanding protection, and fault ride-through capabilities. Reliability assessment of DG-based power networks and mitigation strategies.								**CO4, CO2**
UNIT-V	**Emerging Trends and Smart Grid Technologies**				**Periods: 12**			
Role of distributed generation in smart grids, integration of DG with IoT and AI-based energy management systems. Distributed energy resources (DER) and vehicle-to-grid (V2G) technologies. Blockchain for decentralized energy transactions. Future trends in DG, including hydrogen-based energy storage and advanced grid-interactive renewable energy systems. Case studies on successful DG implementations.								**CO5, CO1**
Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**			**Total Periods: 60**			

Reference Books:

1. H. Lee Willis and Walter G. Scott, Distributed Power Generation: Planning and Evaluation, 1st EditionCRC Press, 2000.
2. N. Jenkins, R. Allan, P. Crossley, D. Kirschen, and G. Strbac, Embedded Generation, 1st Edition,The Institution of Engineering and Technology (IET), 2000.
3. M. Godoy Simoes and Felix A. Farret, Renewable Energy Systems: Design and Analysis with Induction Generators, 2nd Edition, CRC Press, 2004.
4. Antonio Moreno-Munoz, Power Quality: Mitigation Technologies in a Distributed Environment, 1st Edition, Springer, 2007.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	3	-	-	2	-	1	-	3	2	2
CO2	3	3	2	3	2	2	-	-	2	-	1	-	3	3	2
CO3	3	3	2	3	2	3	-	3	2	2	1	-	3	3	3
CO4	3	3	2	3	2	2	-	-	2	-	1	-	3	3	3
CO5	3	3	2	3	2	3	-	3	2	1	1	-	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Sixth**			Course Category Code: **PEC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUE112	**High Voltage Engineering**		3	1	-	4	40	60	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	To understand electrical field distribution and provide knowledge on ionization process and electrical breakdown in gases, solids and liquids and its applications.							
	CO2	To provide knowledge on generation of High AC voltage and AC high current, transformers and rectifiers.							
	CO3	To familiarize measurements of High AC voltage and current, dielectric losses and partial discharge.							
	CO4	To make students understand the over voltage and its insulation, cloud charges, lightening stokes and its characteristics.							
	CO5	Explore high voltage testing, testing of insulators and bushings, isolators and circuit breakers and High voltage laboratory layout.							
UNIT-I	**Electric Fields, Over Voltages and Insulation Co Ordinations**					**Periods: 12**			
Electric fields due to point, line, surface and volume charge distributions – Flux density – Applications of Gauss' Law– Potential field-Potential gradient – Field due to dipoles – dipole moment – Energy density - Conductivity and resistivity of materials –permittivity - Dielectric constant and Dielectric Strength – Boundary conditions – Capacitance of system of conductors– Polarization in dielectrics – Energy stored in a capacitor–-Poisson's and Laplace equations. Charge formation in clouds - Lightning strokes and characteristics - Causes of over voltages – Switching and power frequency over voltages, control and Protection –Insulation coordination.									**CO1**
UNIT-II	**Generation of High Voltages and High Currents:**					**Periods: 12**			
Generation of high AC voltages: cascaded transformers. Generation of high DC voltages: Rectifier and Voltage doubler circuits -Cockroft Walton voltage multiplier circuit and its qualitative analysis, Generation of impulse and switching voltages: Marx circuit, Generation of high impulse currents - Tripping and control of impulse generators.									**CO2**
UNIT-III	**Measurement of High Voltages and High Currents:**					**Periods: 12**			
Measurement of AC, DC impulse and switching surges using sphere gaps - peak voltmeters - potential dividers and high speed CRO - Dielectric loss measurement at power frequency using Schering bridge - Partial discharge measurement.									**CO1, CO3**
UNIT-IV	**Electrical Breakdown in Gases, Solids and Liquids:**					**Periods: 12**			
Ionization processes - Townsend & Streamer theory - the sparking voltage - Paschen's law - Time lag for breakdown - Breakdown in non-uniform fields and corona discharges-Conduction and breakdown in pure and commercial liquids and solids dielectrics and composite dielectrics- Vacuum breakdown- Applications of insulating materials.									**CO1, CO4**
UNIT-V	**High Voltage Testing Practice:**					**Periods: 12**			
Indian Standards/IEC specification for testing - correction factor - testing of insulators and bushings , isolators and circuit breakers -testing of cables, power transformers, surge diverters - High voltage laboratory layout.									**CO5**
Lecture Periods: 45	**Tutorial Periods: 15**		**Practical Periods: 0**			**Total Periods: 60**			

Reference Books:

1. M.S. Naidu and N. Kamaraju, "High voltage Engineering", Sixth edition, Tata McGraw Hill publishing company, New Delhi, 2020.
2. E. Kuffel and W.S. Zaengel, "High voltage Engineering Fundamentals", Pergamon Press, Oxford, London, 2004.
3. C. L. Wadhwa, “High Voltage Engineering”, Fourth Edition, New Age International Publishers,2020.
4. R. Arora and W. Mosch “High Voltage and Electrical Insulation Engineering”, John Wiley & Sons, 2011.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	-	2	1	1	1	-	-	1	-	-
CO2	3	1	1	1	-	-	-	1	1	-	1	2	-	2
CO3	3	1	1	1	-	2	1	1	1	-	1	1	-	2
CO4	2	2	1	1	-	2	-	1	1	-	1	2	-	3
CO5	1	1	1	2	-	3	2	1	1	-	1	1	-	-

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE113	**Embedded Systems**	3	1	-	4	40	60	100
Prerequisite:	Microprocessors and Microcontrollers							
Course Outcome: At the end of the course students will be able to	**CO1**	Ability to understand and analyze Embedded systems.						
	CO2	Acquire the knowledge of embedded networking and bus Communication in processors						
	CO3	Capability to design various Embedded system Development Strategies						
	CO4	Understanding of the basic concepts of real time operating system on various processor scheduling algorithms						
	CO5	Have knowledge of typical applications						
UNIT-I	**Introduction to Embedded Systems**				**Periods: 12**			
Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.								**CO1**
UNIT-II	**Embedded Networking**				**Periods: 12**			
Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I^2C) –need for device drivers.								**CO2**
UNIT-III	**Embedded Firmware Development Environment**				**Periods: 12**			
Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent model, object oriented model.								**CO3**
UNIT-IV	**RTOS Based Embedded System Design**				**Periods: 12**			
Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines, RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication –synchronization between processes semaphores, Mailbox, pipes, priority inversion, priority inheritance.								**CO4**
UNIT-V	**Embedded System Application and Development**				**Periods: 12**			
Case Study of Washing Machine- Automotive Application- Smart Card System Application-ATM machine – Digital camera								**CO5**
Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**			**Total Periods: 60**			

Reference Books:

1. Peckol, “Embedded system Design”, John Wiley & Sons, 2009
2. Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2013
3. Shibu. K.V, “Introduction to Embedded Systems”, McGraw Hill, 2017.
4. Raj Kamal, ‘Embedded System-Architecture, Programming, Design’, McGraw Hill, 2014.
5. C.R. Sarma, “Embedded Systems Engineering”, University Press (India) Pvt. Ltd, 2013.
6. Tammy Noergaard, “Embedded Systems Architecture”, Elsevier, 2012.
7. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufmann Publishers, Third reprint, Harcourt India, 2012.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	1	-	1	-	-	-	-	2	1	1
CO2	3	3	3	2	1	1	-	1	-	-	-	-	2	1	1
CO3	3	3	3	2	1	1	-	1	-	-	-	-	2	1	1
CO4	3	3	3	3	1	1	-	2	1	2	-	2	2	1	1
CO5	3	3	3	3	2	1	-	1	1	3	-	2	2	1	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE114	**Electric Power Quality**	3	1	-	4	40	60	100
Prerequisite:	Power System Analysis, Power Electronics							

Course Outcome: At the end of the course students will be able to		
	CO1	Comprehend concept of Power Quality and its standards and the issues for various electrical systems.
	CO2	The students will be able to identify the power quality problems, causes and suggest suitable mitigating techniques
	CO3	Understand the effect of over voltages.
	CO4	Identify sources of harmonics and understand their effects on power system components.
	CO5	Know different techniques for power quality monitoring.

UNIT-I	**Introduction to Electric Power Quality**	**Periods: 12**
Terms and Definitions: overloading – under voltage – over voltage. concepts of transients – short duration variations such as interruption – long duration variation such as sustained interruption. sags and swells – voltage sag – voltage swell – voltage imbalance – voltage fluctuation – power frequency variations. IEEE/IEC standards of power quality. Power Acceptability curve (CBEMA).		**CO1**
UNIT-II	**Voltage Sags and Interruptions**	**Periods: 12**
Sources of sags and interruptions – estimating voltage sag performance – analysis and calculation of various faulted condition - voltage sag due to induction motor starting- estimation of the sag severity – mitigation of voltage sags, active series compensators. static transfer switches and fast transfer switches.		**CO1, CO2**
UNIT-III	**Overvoltages**	**Periods: 12**
Sources of overvoltages – capacitor switching – lightning – ferro resonance. mitigation of voltage swells – surge arresters – low pass filters – power conditioners. lightning protection – shielding – line arresters – protection of transformers and cables. An introduction of recent tools for analysing transients.		**CO2, CO3**
UNIT-IV	**Harmonics**	**Periods: 12**
Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics – harmonics vs transients. Effect of harmonics – harmonic distortion – voltage and current distortion – harmonic indices – inter harmonics – resonance. Harmonic distortion evaluation – devices for controlling harmonic distortion – passive and active filters. IEEE and IEC standards.		**CO4, CO1**
UNIT-V	**Power Quality Monitoring**	**Periods: 12**
Monitoring considerations, historical perspective of power quality measuring instruments, power quality measurement equipment – monitoring and diagnostic techniques for various power quality problems– power line disturbance analyzer – harmonic / spectrum analyzer – flicker meters – disturbance analyser Applications of AI for power quality monitoring.		**CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H. WayneBeaty, “Electrical Power Systems Quality”, McGraw Hill, 2012.
2. Simmi P Burman, Bipin Singh, “Power Quality”, Katson books, 2012.
3. J. Arrillaga, N.R. Watson, S. Chen, “Power System Quality Assessment”, Wiley, 2011.
4. C. Sankaran, “Power Quality”, CRC Press, Taylor & Francis Group, 2017.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3	2	3	2	-	-	-	2	-	1	2	2	1
CO2	2	3	3	3	2	2	-	1	2	1	1	2	2	1
CO3	2	3	3	3	2	-	-	1	2	1	1	2	2	1
CO4	2	3	3	3	2	2	-	1	2	1	1	2	2	1
CO5	1	3	2	3	2	-	-	-	2	-	1	2	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
EEUE115	**FACTS Controllers**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
		3	1	-	4	40	60	100
Prerequisite:	Power Electronics, Power System Analysis							
Course Outcome: At the end of the course students will be able to	**CO1**	**Understand the fundamentals of power transmission and compensation techniques** to analyze power flow control and the need for FACTS controllers.						
	CO2	**Examine the working principles and control characteristics of shunt compensation techniques**, including Thyristor Controlled Reactor (TCR), Thyristor Switched Capacitor (TSC), and Static VAR Compensators (SVC).						
	CO3	**Analyze the operation and modeling of series compensation techniques**, such as Thyristor Controlled Series Compensator (TCSC), and their impact on system damping and sub-synchronous resonance mitigation.						
	CO4	**Explore voltage source converter-based FACTS devices**, including STATCOM and SSSC, to evaluate their control strategies, steady-state behavior, and real power compensation capabilities.						
	CO5	**Investigate the principles and control mechanisms of advanced FACTS controllers**, such as Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC), for enhanced real and reactive power flow management.						
UNIT-I	**Introduction**				**Periods: 12**			
Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.								**CO1, CO5**
UNIT-II	**Thyristor Controlled Shunt Compensator**				**Periods: 12**			
Objective of shunt compensation–Principle and operating characteristics of Thyristor Controlled Reactor (TCR)–Thyristor Switched Capacitor (TSC)–Static VAR Compensators (SVC)–SVC control system–SVC voltage regulator model–Transfer function and dynamic performance of SVC–Transient stability enhancement and power oscillation damping.								**CO1, CO2**
UNIT-III	**Thyristor Controlled Series Compensator (TCSC)**				**Periods: 12**			
Series compensation–Principles of operation of TCSC–Capability characteristics of TCSC–Modeling of TCSC– TCSC control system– enhancement of system damping– mitigation of sub-synchronous resonance.								**CO3, CO2**
UNIT-IV	**Voltage Source Converter Based Shunt and Series Compensators**				**Periods: 12**			
Static Synchronous Compensator (STATCOM) - Principle of operation- VI Characteristics-Harmonic performance – Steady state model– Static Synchronous Series Compensator (SSSC)-Principle of operation and characteristics of SSSC–control range and VA rating–capability to provide real power compensation – Internal and External control schemes for SSSC.								**CO3, CO4**
UNIT-V	**UPFC and IPFC**				**Periods: 12**			
Unified power flow controller (UPFC) - Basic operating principles–conventional transmission control capabilities – Independent Real and reactive power flow control– control structure. Interline power flow controller (IPFC) - Basic operating principles and characteristics – Control structure.								**CO4, CO5**
Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**			**Total Periods: 60**			

Reference Books:

1.Narain G.Hingorani and Laszlo Gyugyi, Understanding FACTS concepts and technology of Flexible AC transmission systems, Edition2001, IEEE Power Engineering Society Sponsor, IEEE press, 2001.

2. R.Mohan Mathur and Rajiv K.Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, Edition February 2002, IEEE press-JohnWiley and Sons publications,2002.

3. Yong Hua Song and Allan T Johns, Flexible AC Transmission System (FACTS), IEEE Power Engineering Series IEEE press,1999.
4. Einar V.Larsen, Jaun J. Sanchez-Gasca and Joe H. Chow, Concepts of design of FACTS Controllers to damp power swings, IEEE Transaction on Power Systems, Vol.10, no.2, May1995.
5. GyugyiL, Unified Power flow control concept for flexible AC transmission, IEEE Proceedings, vol.139, no.4, July 1992.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	1	1	-	1	-	1	1	1	1	2	2	1
CO2	2	2	2	1	-	1	-	1	1	1	1	2	2	1
CO3	2	2	2	1	-	1	-	1	1	1	1	2	2	1
CO4	2	2	2	1	-	1	-	1	1	1	1	2	2	1
CO5	2	2	2	1	-	1	-	1	1	1	1	2	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE116	**High Voltage Direct Current Transmission**	3	1	-	4	40	60	100

Prerequisite:		
Course Outcome: At the end of the course students will be able to	**CO1**	Understand the advantages of dc transmission over ac transmission.
	CO2	Understand the operation of line commutated converters.
	CO3	Understand the HVDC faults and protection.
	CO4	Understand the reactive power management and harmonics elimination in HVDC systems.
	CO5	Understand the multi terminal HVDC transmission systems.

UNIT-I	**Introduction to High Voltage Transmission Systems**	**Periods: 12**
Introduction-Historical sketch- Comparison of AC and dc Transmission -Types of HVDC Systems - Components of a HVDC system - Application of DC Transmission- Planning & Modern trends in D.C. Transmission.		**CO1 CO2**
UNIT-II	**Analysis of HVDC Converters**	**Periods: 12**
Line commutated converter; Analysis of Graetz circuit with and without overlap –Pulse number– Choice of converter configuration – Converter bridge characteristics– Analysis of 12 pulse converters– Analysis of VSC topologies and firing schemes.		**CO1 CO2**
UNIT-III	**HVDC Faults and Protection**	**Periods:12**
Converter faults, commutation failure–Disturbance caused by over current and over Voltage –Protection against over current and over voltage–Surge arrestors smoothing reactors– Corona effects of DC line – Transient over voltages for DC line– Protection of DC links.		**CO2 CO3**
UNIT-IV	**Reactive Power and Harmonics in HVDC**	**Periods:12**
Sources of reactive power-static VAR system–Reactive power control during transients– generation of harmonics–Types and design of various AC filters, DC filters–interference- telephone-RI noise.		**CO2 CO3 CO4**
UNIT-V	**Multi Terminal HVDC Systems**	**Periods: 12**
Types of MTDC system–Comparison of series and parallel MTDC system–HVDC insulation–DC line insulators – DC breakers – Characteristics and types of DC breakers.		**CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers; Third edition, 2016.
2. 2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. 3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.
4. 4. Vijay K. Sood, HVDC and FACTS Controller: Application of Static Converters in Power Systems, IEEE Power Electronics and Power Systems series, Kluwer Academic publishers, Boston, First edition January 2004.
5. 5. S. Kamakshaiah and V. Kamaraju, "HVDC Transmission" , McGraw Hill publishers, First edition, 2017.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	3	-	-	1	1	1	2	1	1
CO2	2	2	1	2	1	3	-	-	1	-	1	2	1	2
CO3	2	1	1	2	1	3	-	-	1	-	-	2	1	2
CO4	2	1	1	2	1	3	-	-	1	-	-	2	1	2
CO5	2	-	1	2	1	3	-	-	1	-	1	2	1	1

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : Seventh		Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	**Course Name**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUE117	**Power System Restructuring and Deregulation**	3	1	-	4	40	60	100
Prerequisite								

Course Outcome: At the end of the course students will be able to		
	CO1	Explore the fundamentals and solve the issues available in restructured power system and can address the problems in the power markets of the world.
	CO2	Gain knowledge about the architecture of power markets and the technical challenges in the transmission sector of the restructured power market
	CO3	Explore the impact of depreciation on the power components and congestion management in the restructured power market
	CO4	Explore the fundamentals of minimizing the cost of generation sources to meet the power system load
	CO5	Gain knowledge about the structure of electrical tariff and study on the current scenario of the Indian power market.

UNIT-I	**Fundamentals of Power Markets**	**Periods: 12**
Fundamental sand structure of Restructured Power Market–Wheeling–Market Power- Power exchange and pool markets-Independent System Operator (ISO)–components- role of ISO- Operating Experiences of Restructured Electricity Markets in various Countries (UK, Australia, Europe, US, Asia).		**CO1, CO5**
UNIT-II	**Transmission Challenges**	**Periods: 12**
Transmission expansion in the New Environment–Introduction–Role of transmission planning– Transmission Capacity–Total Transfer Capability (TTC) – Computational procedure - Margins–Available transfer capability (ATC)–Principles–Constraints-Methods to compute ATC.		**CO2, CO3**
UNIT-III	**Congestion Management and Ancillary Services**	**Periods: 12**
Concept of Congestion Management–Method store lieve the congestion-Inter and Intra zonal Congestion Management–Generation Rescheduling – Locational Marginal Pricing–Financial Transmission Right-Ancillary Services.		**CO3, CO4**
UNIT-IV	**Transmission Pricing**	**Periods: 12**
Transmission pricing methods -Postage Stamp-Contract path-MW-mile– MVA mile– Distribution Factor method–Tracing method- Short run marginal cost (SRMC)–Generator Ramping and Opportunity Costs.		**CO4**
UNIT-V	**Indian Power Market**	**Periods: 12**
Current Scenario – Regions–Salient features of Indian Electricity Act 2003 – Regulatory and Policy development in Indian power Sector – Availability based tariff – Necessity–Working Mechanism – Unscheduled Interchange Rate – Operation of Indian Power Exchange.		**CO1, CO5**

Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. M. Shahidehpour and M. Alomoush, Restructuring Electrical Power Systems, Marcel Decker Inc., 2021.
2. M. Shahidehpour, H. Yamin and Z. Li, Market Operations in Electric Power Systems, John Wiley &Sons, Inc., 2022.
3. Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder, Operation of Restructured Power Systems, Kluwer Academic Publishers, 2011.
4. L. L. Lai, Power system Restructuring and Regulation, John Wiley sons, 2001.
5. Scholarly Transaction Papers, Utility and Power Exchange web sites.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3	1	2	3	3	3	1	2	2
CO2	2	2	3	3	2	2	-	-	2	-	2	1	1	2
CO3	2	3	2	3	2	2	-	1	2	-	2	1	1	2
CO4	2	3	3	3	3	2	-	1	2	-	2	2	1	1
CO5	3	2	2	2	1	3	1	2	3	3	3	1	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Seventh**			Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUE118	**Smart Grid**		3	1	-	4	40	60	100
Prerequisite:									
Course Outcome: At the end of the course students will be able to	**CO1**	Understand the concept of Smart Grid.							
	CO2	Understand the rationale for smart grid technology and its characteristics.							
	CO3	Understand different smart meters, advanced metering infrastructure and power quality management.							
	CO4	Know more about communication protocols and control capabilities that will optimize the operation							
	CO5	Familiarize with power quality management for the smart grid applications							
UNIT-I	**Introduction to Smart Grid**					**Periods: 12**			
Evolution of Electric Grid–Need for smart grid– Difference between conventional & smart grid – Overview of enabling technologies–International experience in smart grid deployment efforts–Smart grid road map for INDIA– Smart grid architecture.									**CO1, CO5**
UNIT-II	**Wide Area Monitoring System**					**Periods: 12**			
Fundamentals of synchro phasor technology – concept and benefits of wide area monitoring system– Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC)– Blackout analysis using PMU.									**CO1, CO2**
UNIT-III	**Smart Meters**					**Periods: 12**			
Features and functions of smart meters– Functional specification–category of smart meters– AMR and AMI drivers and benefits– AMI protocol– Demand Side Integration-Peak load, Outage and Power Quality management.									**CO1, CO3, CO5**
UNIT-IV	**Information and Communication Technology**					**Periods: 12**			
Overview of smart grid communication system– Radio communication–Mobile communication–Power line communication– Optical fibre communication –Communication protocol for smart grid.									**CO4, CO5**
UNIT-V	**Smart Grid Applications**					**Periods: 12**			
Overview and concept of renewable integration – role of protective relaying in smart grid– House Area Network– Advanced Energy Storage Technology -SMES–Super capacitors–Plug–in Hybrid electric Vehicles– Cyber Security requirements–Smart grid information model.									**CO1, CO5**
Lecture Periods: 45	**Tutorial Periods: 15**		**Practical Periods: 0**				**Total Periods: 60**		

Reference Books:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins, Smart Grid Technology and Applications, John Wiley & Sons Publication, 2012.
2. James Momoh, Smart Grid Fundamentals of Design and Analysis, Wiley India Pvt. Ltd., 2018.
3. Krzysztof Iniewski, Smart Grid Infrastructure and Networking, McGraw Hill Education (India) Pvt. Ltd., 2014.
4. Fereidoon. P. Sioshansi, Smart grid – integrating renewable, distributed and efficient energy, Academic Press, 2011.
5. Stuart Borlase, Smart Grids: Infrastructure, Technology and Solutions, CRC Press Publication, 2013.
6. Bharat Modi, Anu Prakash & Yogesh Kumar, Fundamentals of Smart Grid Technology, S.K. Kataria & Sons, 2022.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	3	2	1	2	-	1	2	-	-
CO2	2	3	3	3	3	3	3	1	2	-	1	2	-	-
CO3	2	3	3	3	3	3	3	1	2	-	1	2	-	-
CO4	2	3	3	3	3	3	3	1	2	-	1	2	-	-
CO5	3	3	3	3	3	2	2	1	2	-	1	3	-	-

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Seventh**			Course Category Code: **PEC**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUE119	**Big Data Analytics in Power Systems**		3	1	-	4	40	60	100
Prerequisite:	Power System Analysis								
Course Outcome: At the end of the course students will be able to	**CO1**	Understand the concepts of data analytics in power systems							
	CO2	Apply various machine learning and classifier algorithms to big data applications in power systems							
	CO3	Analyse various techniques in data security in Smart Grid Communications							
	CO4	Apply various Optimization methods in data analytics							
	CO5	Apply the data analytics in power system operation, control and protection paradigms							
UNIT-I	**Data in power systems Introduction**					**Periods: 12**			
Big Data-Future Power Systems-Big Data Application and Analytics in a Large-Scale Power System-Role of Big Data Analytics in Smart Grid Communications-Big Data Optimization in Electric Power Systems: A Review - Security Methods for Critical Infrastructure Communications- Data Mining Methods for Electricity Theft Detection - Unit Commitment Control of Smart Grids - Data-Based Transformer Differential Protection.									**CO1**
UNIT-II	**Big data application in large-scale power system**					**Periods: 12**			
Big Data Application and Analytics in a Large-Scale Power System: General Applications of Big Data-Health Care-Social Networking-Handling Big Data. Algorithms for Processing Big Data-Machine Learning and Deep Learning Generalities. Machine Learning- Artificial Neural Network (ANN) Model-Support Vector Machine (SVM)- Decision-Tree Classifier. Deep Learning-Deep Learning Models-Challenges and Suggested Solutions for Using Deep Learning in Big Data Analytics. Application of Big Data in Power Systems-Big Data in Smart Grid Networks-Phasor Measurement Units (PMU)- Renewable Energy-CIM as Information Standard for Big Data Analytics-Big Data Problem in Power System Modeling-Security-Constrained Unit Commitment (SCUC)- Decomposition Methods to Handle Big Data-Firm Transmission Right (FTR) Problems-Time-Constrained Economic Dispatch									**CO1, CO2**
UNIT-III	**Big Data security in Smart Grid Communications**					**Periods: 12**			
Role of Big Data in Smart Grid Communications: Grid Modernization-Grid Interconnection with the Internet of ThingsData Traffic Pattern in a Smart Grid Environment-Phasor Measurement Unites Applied to Distribution Systems-Advanced Metering Infrastructure (AMI)- Massive Flow of Information in a Smart Scenario-Volume of Generated Data in a Smart Distribution System: Case Studies-Generated Data by PMUs-Generated Data by Metering Infrastructure - Data Mining Methods for Electricity Theft Detection: Introduction-Transmission and Distribution System Losses-Electricity Theft Methods-Fraud-Bypassing Existing Meetings-Meter Tampering-Billing Issues-Outright Theft-Electricity Theft and Data Collection-Data Mining and Electricity Theft-Prediction-Classification and Clustering-Issues and Directions in Electricity Theft-Related Data-Mining Research									**CO2, CO3**
UNIT-IV	**Big Data Optimization in Electric Power Systems**					**Periods: 12**			
Big Data Optimization in Electric Power Systems: Background-Scientometric Analysis of Big Data-Big Data and Power Systems-Big Data Optimization-Application of Big Data in Power System Studies. Optimization Techniques Used in the Big Data Analysis-Computational Method for Large-scale Unconstrained Optimization - Numerical Approach for Nonsmooth Large-scale Optimization-Big Data in Logistics Optimization-Big Data Analytics Based on Convex and Nonconvex Optimization-Metaheuristic Algorithms for Big Data Optimization									**CO4**
UNIT-V	**Data in control and protection**					**Periods: 12**			
Multi-agent Architecture-Smart Grid Using Multi-Agent Model-Agent's Profle-Decision-Making Method-Storing and Selling Extra Power Procedure-Examples Protection Algorithm Based on Data Pattern									**CO1, CO5**

Recognition: Big Data and Power System Protection-Methods for Differential Protection Blocking - Harmonic Restraint and Harmonic Blocking-Methods Based on Waveform Recognition - Principal Component Analysis-Curvilinear Component Analysis (CCA)- PCA Applied to Discriminate Between Inrush and Fault Currents in Transformers- Application of the CCA as a Base for a Differential Protection			
Lecture Periods: 45	**Tutorial Periods:15**	**Practical Periods: 0**	**Total Periods: 60**

Reference Books:

1. Ahmed F. Zobaa and Trevor J. Bihl [Edited], Big Data Analytics in Future Power Systems, CRC Press,Taylor & Francis Group, 2019
2. Reza Arghandeh and Yuxun Zhou [Edited]., Big Data Application in Power Systems, Elsevier, 2018
3. Robert C. Qiu and Paul Antonik, Smart Grid using Big Data Analytics: A Random Matrix Theory Approach, John Wiley & Sons Ltd, 2017
4. Patrick C. K. Hung [Edited],Big Data Applications and Use Cases, Springer International Publishing Switzerland 2016

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3	3	3	2	-	-	-	2	-	1	2	2	2
CO2	2	3	3	3	3	2	-	1	2	1	1	2	2	2
CO3	2	3	3	3	3	-	-	1	2	1	1	2	2	2
CO4	2	3	3	3	3	2	-	1	2	1	1	2	2	2
CO5	1	3	2	3	3	-	-	-	2	-	1	2	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Annexure III

Syllabi of Ancillary Stream Courses offered by the Department of Electrical and Electronics Engineering

Ancillary Stream Elective – 1: GREEN ENERGY

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fourth**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	Course Name:	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUN101	**Renewable Energy Technologies and Grid Integration**	3	-	-	3	40	60	100
Prerequisite:								
Course Outcome: At the end of the course the students will be able to	**CO1**	Develop a deep understanding of various renewable energy sources and recognize their role in achieving global sustainability goals						
	CO2	Evaluate various renewable energy conversion technologies and their applications in real-world scenarios.						
	CO3	Explore the concept of hybrid systems and their advantages in providing reliable and sustainable energy.						
	CO4	Examine the challenges and solutions related to integrating renewable energy sources into existing power grids.						

UNIT-I	**Introduction**	**Periods: 9**
Conventional Energy Sources, Non-Conventional Energy Sources, Renewable Energy Potential, availability of solar, wind, biogas, natural gas, forest produce, tidal, geothermal, mini-hydro sources – Energy storage-Need for Energy Storage, Energy storage Devices(batteries, super capacitors, pumped hydro, flywheels)- Energy consumption in various sectors - Environmental impacts - World Energy Scenario, Indian Energy Scenario, Renewable Energy Polices of India, Indian Solar Energy Mission.		**CO1**
UNIT-II	**Solar PV systems**	**Periods: 9**
Solar energy fundamentals – sun, earth relationship - radiation spectrum – solar constant - measurement of solar irradiance - solar thermal systems- principle and types of solar collector -solar water heater- solar photovoltaic systems: PV effect- solar cell, module, array – I-V and P-V characteristics of solar cell - solar PV system –applications- PV based Hybrid energy system.		**CO2, CO3**
UNIT-III	**Wind Energy Systems**	**Periods: 9**
Wind Energy- Nature and characteristics of Wind, Power available in the wind - construction and working of HAWT and VAWT Wind Turbines- Yaw and Pitch Control - Power output from Wind Turbines - Betz Law - Power Curve -– Various Wind Power Generators- Important Parameters for Site selection - Wind Farm design - Micro / Small Wind Turbines, Wind-PV Hybrid Energy system.		**CO2, CO3**
UNIT-IV	**Ocean Energy and Geothermal Energy systems**	**Periods: 9**
Energy from tides and waves - working Principle of tidal plants - Wave Energy Conversion Systems - ocean thermal energy conversion (OTEC) - Geothermal energy - types of geothermal resources - geothermal power plants		**CO2**
UNIT-V	**Grid Integration of Renewables**	**Periods: 9**
Challenges in Grid Integration, Balancing Mechanisms, Ancillary Services - Frequency Regulation, voltage control and reactive power support, power quality management system, battery support and grid connected inverter during islanding. Case studies – Renewable energy in remote India, Off shore windfarm, Microgrid.		**CO4**

Lecture Periods: 45	Tutorial Periods: 0	Practical Periods: 0	Total Periods: 45

Reference Books:

1. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 2003.
2. D.P. Kothari, K.C. Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learning Private Limited, New Delhi, 2011
3. Khan B H, “Non-Conventional Energy Resources”, Tata McGraw-Hill, New Delhi 2010
4. Mukund R Patel, “Wind and Solar Power Systems”, CRC Press, New York, 2011.
5. Solanki, Chetan Singh, " Solar Photovoltaics - Fundamentals, Technologies and Applications", PHI, New Delhi, 2015.
6. Bhadra S N, Banerjee S, Kastha D, “Wind Electrical Systems”, Oxford University Press, New Delhi, 2008

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2	2	-	2	-	3	3	-	3	3	2	3
CO2	3	3	3	3	3	2	-	3	2	-	3	3	3	2
CO3	3	1	2	1	2	2	-	3	2	-	3	3	2	3
CO4	3	3	3	3	3	2	-	2	2	-	2	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department: **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Fifth**			Course Category Code: **ANC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUN102	**Power Converters for Renewable Energy Systems**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome: At the end of the course the students will be able to	**CO1**	Analyze different power converter topologies (AC-DC, DC-DC, DC-AC) used in solar, wind, and energy storage systems.							
	CO2	Apply Pulse Width Modulation (PWM) strategies for efficient power conversion and voltage regulation in renewable energy systems.							
	CO3	Develop competency in implementing control strategies for power converters, including maximum power point tracking (MPPT) techniques for optimizing energy extraction from sources like photovoltaic/Wind systems.							
	CO4	Learn the principles and practices involved in integrating different renewable energy sources using a common multiport converter							
UNIT-I	**AC-DC Converters**					**Periods: 9**			
Static Characteristics of power diode, SCR and MOSFET, GTO and IGBT, Single-phase semi and full converters with R and R-L loads - inversion mode operation - Effect of freewheeling diode -Three-phase full converter with R, R-L loads - performance parameters									**CO1**
UNIT-II	**DC – DC Converters**					**Periods: 9**			
Step down chopper - control strategies, time ratio control, variable frequency control, Step up chopper, 2-quadrant &4-quadrant choppers, switched mode regulators - principle of operation of buck , boost and buck-boost regulators -Bidirectional converter.									**CO1, CO2**
UNIT-III	**Inverters**					**Periods: 9**			
Single phase bridge inverter- working- waveforms for different types of loads, performance parameters - Three phase voltage source inverter- output analysis with balanced star connected R load – voltage and frequency control of Inverters– PWM techniques - harmonics study - Grid-Interactive Inverters.									**CO1, CO2**
UNIT-IV	**Analysis of Power converters for Solar PV Systems**					**Periods: 9**			
Solar PV Power plant – system description, working, role of DC-DC and DC -AC converter, charge controllers for off-grid and Hybrid systems. Control techniques- PWM control, MPPT control. Grid connected PV systems- Net metering, Grid synchronization. Case studies: Real-world case studies of power converters in Grid-Tied Solar Photovoltaic System, rooftop solar PV system.									**CO3, CO4**
UNIT-V	**Analysis of Power converters for Wind Energy Systems**					**Periods:9**			
Wind Energy Systems: Variable speed Wind Energy Generation Schemes (Induction and synchronous generator based)– Voltage and frequency control, Reactive power support- Grid connected wind energy system - stand-alone mode of operation – Direct driven Wing Energy Generation- Applications . Case studies: Offshore Wind Farm , wind-PV-battery based hybrid energy system.									**CO3, CO4**
Lecture Periods:	**Tutorial Periods:**		**Practical Periods:**			**Total Periods:**			

Reference Books:

1. M.H. Rashid, "Power Electronics", PHI, New Delhi, 2007.
2. P.S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 2022.
3. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, 2003.
4. D.P. Kothari, K.C. Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, New Delhi,3rd edition, 2021
5. Khan B H, "Non-Conventional Energy Resources", Tata McGraw-Hill, New Delhi 2017
6. Thakur Nivedita, Mukerjee A. K, "Photovoltaic Systems", PHI , 2012
7. Felix Rojas Lobos, Edson Bim, Javier Pereda Torres, "Power Electronics for Solar and Wind Energy Conversion Systems", Elsevier, 2025
8. Bimal K. Bose "Power Electronics in Renewable Energy Systems and Smart Grid", Wiley, 2019.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	3	2	-	3	3	2	3	3	2	2
CO2	3	3	3	3	3	2	-	3	3	2	3	2	3	3
CO3	3	3	2	3	2	2	-	3	3	1	3	3	2	3
CO4	3	3	3	3	3	2	-	2	2	2	2	3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Sixth**			Course Category Code: **ANC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUN103	**Distributed Generation and Energy Storage**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome: At the end of the course the students will be able to	**CO1**	Explain DG fundamentals, technologies, and grid integration challenges.							
	CO2	Analyze energy storage technologies, performance metrics, and selection criteria.							
	CO3	Evaluate economic/environmental impacts of storage integration in microgrids.							
	CO4	Assess regulatory frameworks, power quality issues, and policy impacts on DG.							
	CO5	Explore emerging trends (V2G, solid-state batteries) and case studies in DG systems.							
UNIT-I	**Fundamentals of Distributed Generation**					**Periods: 9**			
Overview of distributed generation, differences from centralized generation, advantages and challenges. Role of DG in modern power systems, impact on grid stability and reliability. Technologies used in DG—solar PV, wind, biomass, fuel cells, micro turbines. DG operation in isolated and grid-connected modes.									**CO1, CO4**
UNIT-II	**Energy Storage Technologies for Distributed Generation**					**Periods: 9**			
Classification of energy storage systems—electrochemical, mechanical, thermal, and hydrogen storage. Battery technologies: lithium-ion, sodium-sulfur, flow batteries, and solid-state batteries. Ultra-capacitors and superconducting magnetic energy storage (SMES). Flywheels and compressed air energy storage (CAES). Hydrogen storage and fuel cell applications. Comparison of different energy storage technologies based on efficiency, cost, and scalability.									**CO2, CO3**
UNIT-III	**Energy Storage Integration and Management**					**Periods: 9**			
Energy storage sizing, selection. Demand response and load shifting strategies. Hybrid energy storage systems and their advantages in DG. Economic analysis of energy storage investment in microgrids. Grid balancing and peak load management. Control and management of distributed energy storage systems.									**CO3, CO5**
UNIT-IV	**Policies, Standards, and Regulatory Frameworks and Power Quality issues in DG Systems**					**Periods: 9**			
National and international grid codes for DG and energy storage integration. IEEE 2030.7 and IEEE 1547 standards for DER operation. Impact of net metering policies on DG adoption. Tariff structures, subsidies, and carbon credit mechanisms for decentralized energy. Regulatory challenges in peer-to-peer (P2P) energy trading. Impact of energy storage on grid stability and reliability. Power quality issues in DG with energy storage.									**CO4, CO1**
UNIT-V	**Advanced Applications and Future Trends**					**Periods: 9**			
Vehicle-to-grid (V2G) and grid-to-vehicle (G2V) technologies. Case studies on large-scale energy storage deployments (e.g., Tesla Megapack, Hornsdale Power Reserve). Future trends in distributed energy storage—solid-state batteries, hydrogen economy, and autonomous energy grids.									**CO5, CO2, CO4**
Lecture Periods: 45	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 45**			

Reference Books:

1. H. Lee Willis and Walter G. Scott, Distributed Power Generation: Planning and Evaluation, 1st Edition CRC Press, 2000.
2. N. Jenkins, R. Allan, P. Crossley, D. Kirschen, and G. Strbac, Embedded Generation, 1st Edition, The Institution of Engineering and Technology (IET), 2000.
3. M. Godoy Simoes and Felix A. Farret, Renewable Energy Systems: Design and Analysis with Induction Generators, 2nd Edition, CRC Press, 2004.
4. Antonio Moreno-Munoz, Power Quality: Mitigation Technologies in a Distributed Environment, 1st Edition , Springer, 2007.
5. Fereidoon P. Sioshansi, Distributed Generation and Its Implications for the Utility Industry, 1st Edition, Academic Press, 2014.
6. Ramesh Bansal," Handbook of Distributed Generation- Electric Power Technologies, Economics, Environmental Impacts" Springer, 2017

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	-	-	-	2	-	1		3	2	2
CO2	3	3	2	3	2	-	-	-	2	-	1		3	3	2
CO3	3	3	2	3	2	3	-	-	2	1	1		3	3	3
CO4	3	3	2	3	2	3	-	-	2	-	1		3	3	3
CO5	3	3	2	3	2	3	-	-	2	1	1		3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUN104	**Energy Management and Energy Audit**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course the students will be able to	**CO1**	Explain energy management fundamentals, conservation techniques, and policy frameworks.
	CO2	Apply energy auditing methods, performance indicators, and instrumentation techniques.
	CO3	Analyze electrical/thermal system efficiency, demand control, and waste heat recovery.
	CO4	Evaluate economic viability of energy projects using life cycle costing and financial metrics.
	CO5	Investigate case studies, DSM strategies, and emerging trends (IoT/AI, renewables).

UNIT-I	**Introduction to Energy Management and Energy Conservation**	**Periods: 9**
Definition and significance of energy management. Need for energy conservation in domestic, commercial, and industrial sectors. Energy management in electrical and thermal utilities. Principles of energy efficiency, energy saving opportunities, and the role of energy managers. National and international policies on energy efficiency.		**CO1, CO5**
UNIT-II	**Energy Auditing Techniques**	**Periods: 9**
Types of energy audits—preliminary audit and detailed audit. Energy audit methodology—data collection, measurement techniques, analysis, and interpretation. Energy performance indicators (EPI), benchmarking, and energy consumption patterns. Use of energy audit instruments—power analyzers, flow meters, infrared cameras, and flue gas analyzers.		**CO2, CO4**
UNIT-III	**Electrical and Thermal Energy Management**	**Periods: 9**
Energy efficiency in electrical systems—transformers, motors, compressors, HVAC systems, lighting, and cogeneration. Power factor correction, demand control, and peak load management. Energy conservation in boilers, steam systems, furnaces, and heat exchangers. Waste heat recovery techniques and thermal insulation.		**CO3, CO1**
UNIT-IV	**Economic Analysis of Energy Projects**	**Periods: 9**
Life cycle costing, simple and discounted payback period, net present value (NPV), internal rate of return (IRR), and cost-benefit analysis for energy projects. Energy tariffs and load management techniques. Government incentives, subsidies, and financial analysis of energy-efficient technologies.		**CO4, CO2**
UNIT-V	**Case Studies and Future Trends in Energy Management**	**Periods: 9**
Energy conservation case studies in industries, commercial buildings, and transportation. Demand-side management (DSM) strategies. Integration of renewable energy sources for improving energy efficiency. Smart grids, IoT-based energy monitoring, and AI-driven energy analytics for predictive maintenance.		**CO5, CO3, CO1**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. P. W. O'Callaghan, Energy Management Principles, 1st Edition, McGraw-Hill, 1993.
2. Albert Thumann, Handbook of Energy Audits, 9th Edition, The Fairmont Press, 2013.
3. B. L. Capehart, W. C. Turner, and W. J. Kennedy, Guide to Energy Management, 8th Edition,The Fairmont Press, 2011.
4. Barney L. Capehart, Energy Management for Buildings and Industry, 1st EditionCRC Press, 2020.
5. Y.P. Abbi and Shashank Jain, Handbook on Energy Audit and Environment Management, 2nd Edition, TERI, 2006.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	3	-	-	2	-	1		3	2	2
CO2	3	3	2	3	2	2	-	-	2	-	1		3	3	2
CO3	3	3	2	3	2	3	-	3	2	2	1		3	3	3
CO4	3	3	2	3	2	2	-	-	2	-	1		3	3	3
CO5	3	3	2	3	2	3	-	3	2	1	1		3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Ancillary Stream Elective – 2: ELECTRIC VEHICLE TECHNOLOGY

Department :**Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Fourth**			Course Category Code: **ANC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUN105	**Hybrid Electric Vehicles**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome: At the end of the course the students will be able to	**CO1**	Explain fundamentals of hybrid/electric vehicles (HEVs), including social/environmental impacts.							
	CO2	Analyze hybrid powertrain architectures, power flow management, and efficiency metrics.							
	CO3	Evaluate electric machine drives (DC, AC, PM, SR) and control strategies for HEVs.							
	CO4	Assess HEV performance through component sizing, energy storage selection, and subsystem integration.							
	CO5	Investigate emerging trends (V2G, solid-state batteries) and case studies in HEV technology.							
UNIT-I	**Introduction to Hybrid Electric Vehicles (HV)**					**Periods: 9**			
A brief history of Electric and Hybrid Vehicles, basic architecture of hybrid drivetrains. Social and Environmental impact of electric and hybrid vehicle technology. Fundamentals of Vehicle propulsion and braking - dynamic equations for vehicles, Vehicle Power Plant and Transmission Characteristics-Vehicle Performance.									**CO1, CO5**
UNIT-II	**Hybrid Train Architectures and Power Flow management**					**Periods: 9**			
Fundamental concept of hybrid traction - Basic concepts of electric traction - introduction to various electric drive - train topologies- Power flow control in hybrid drive- fuel efficiency analysis.									**CO2, CO4**
UNIT-III	**Electric Machines and Drive in Hybrid Electric Vehicles**					**Periods: 9**			
Configuration and control of DC Motor drives - AC Motor drives - Permanent Magnet Motor drives - Switch Reluctance Motor drives									**CO3, CO2**
UNIT-IV	**Performance Analysis of Hybrid Electric Vehicles**					**Periods: 9**			
Matching the electric machine and the internal combustion engine (ICE) - Sizing the propulsion motor - power electronic components - selecting of energy storage technology- communications – supporting subsystems									**CO4, CO3**
UNIT-V	**Recent Trends and Case Studies**					**Periods: 9**			
Recent advancements in hybrid electric vehicle technologies, and smart grid integration for HEVs. Environmental and economic impacts of widespread HEV adoption. Future trends in HV development, including solid-state batteries, vehicle-to-grid (V2G) and grid to vehicle (G2V) technology. Case studies of commercial hybrid electric vehicles.									**CO5, CO1, CO2**
Lecture Periods: 45	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 45**			

Reference Books:

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals”, 2nd Edition, CRC Press, 2010.
2. James Larminie, John Lowry “Electric Vehicle Technology Explained”, 1st Edition, John Wiley and Sons, 2003.
3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, Wiley publication,2011.
4. Allen Fuhs, “Hybrid Vehicles and the future of personal transportation”, CRC Press, 2009.
5. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybridand Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	2	-	-	2	-	1		3	2
CO2	3	3	3	3	2	-	-	-	2	-	1		3	3
CO3	3	3	3	3	2	-	-	-	2	-	1		3	3
CO4	3	3	3	3	2	3	-	-	2	-	1		3	3
CO5	3	2	2	3	2	3	-	-	2	-	1		3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Fifth**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUN106	**Battery Management System**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course the students will be able to	**CO1**	To provide knowledge on lithium-ion cell types, datasheet reading, dimensions, maximum charge/discharge currents, and lifecycle considerations.
	CO2	To provide knowledge on battery pack design focusing on electrical, mechanical, and thermal aspects for optimization
	CO3	To familiarize battery management systems, including standalone and master-slave configurations, and their functionalities.
	CO4	To make students' understand state-of-charge (SOC) and state-of-health (SOH) estimation techniques using various methodologies.
	CO5	Explore emerging trends, advanced control techniques, and case studies in EV powertrains.

UNIT-I	**Introduction**	**Periods: 9**
Introduction to Energy storage solutions - Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging. Cooling mechanism of Batteries		**CO1**
UNIT-II	**Battery Management System Requirement:**	**Periods: 9**
Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of- charge estimation, Cell total energy and cell total power.		**CO1, CO2**
UNIT-III	**Battery State of Charge and State of Health Estimation, Cell Balancing:**	**Periods: 9**
Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing. Cycle Ageing, Calendar Ageing in Batteries.		**CO1, CO3**
UNIT-IV	**Modelling and Simulation:**	**Periods: 9**
Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, Simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery pack.		**CO3, CO4**
UNIT-V	**: Design of battery BMS & Battery Pack design:**	**Periods: 9**
Design principles of BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery systems. Electrical, mechanical, thermal and electronics design consideration of battery pack. Battery Module: Cylindrical, Prismatic and Pouch.		**CO1, CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, G., Battery Management Systems: Volume II, Equivalent-Circuit Methods, Artech House, 2015
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech

House, 2010
5. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.
6. John Warner, "The Handbook of Lithium-Ion Battery Pack Design: Chemistry, Components, Types and Terminology", Elsevier 2015
7. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2002
8. Datasheets: LTC3300 – X, ISL94216A
9. Standards: AIS – 038, AIS – 156
10. BQ79606A – Q1 Evaluation module user guide
11. BQ79606A – Q1 Datasheet
12. https://ti.com/lit/ug/slou471e/slou471e.pdf?ts=1705051471748&ref_url=https%253A%252F%252Fwww.ti.com%252Ftool%252FBQ79606EVM-897
13. https://ti.com/lit/ds/slusdq4/slusdq4.pdf?ts=1705051477267&ref_url=https%253A%252F%252Fwww.ti.com%252Ftool%252FBQ79606EVM-897

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	2	1	1	-	1	3		
CO2	3	3	2	1	-	2	-	1	1	-	1	2	1	2
CO3	3	3	1	1	-	3	-	1	1	-	-	2		1
CO4	2	2	1	1	1	-	-	1	1	-	-	1	2	
CO5	2	3	2	1	1	2	-	1	1	-	2	1	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUN107	**Electric Vehicle Power Train**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course the students will be able to	**CO1**	Analyze the architecture, components, and working principles of electric vehicle (EV) powertrains, including torque-speed characteristics and dynamic modeling.
	CO2	Evaluate different electric propulsion systems (DC, Induction, PMSM, SRM) and their efficiency characteristics, including regenerative braking strategies.
	CO3	Design and optimize energy management systems, charging strategies, and battery life extension techniques for EV powertrains.
	CO4	Develop motor drive systems and power converters (DC-DC, inverters) for EVs using advanced control techniques (FOC, DTC) and efficiency optimization.
	CO5	Investigate emerging trends (AI, IoT, solid-state batteries) and case studies (Tesla, Lucid Air) in EV powertrains, including high-voltage architectures.

UNIT-I	**Fundamentals of Electric Vehicle Powertrain**	**Periods: 9**
Overview of electric vehicle powertrain architecture, comparison with internal combustion engine (ICE) powertrains. Key components of EV powertrains—electric motors, inverters, energy storage systems, transmission systems, and controllers. Torque-speed characteristics of electric motors, drivetrain efficiency, and vehicle performance factors. Dynamic modeling of electric vehicles and traction characteristics.		**CO1, CO5**
UNIT-II	**Electric Propulsion Systems**	**Periods: 9**
Types of electric propulsion—single motor, dual motor, and in-wheel motor configurations. Comparison of DC motors, Induction motors, Permanent Magnet Synchronous motors (PMSM), and Switched Reluctance motors (SRM) for EV applications. Torque control and speed regulation strategies for electric propulsion. Performance analysis of direct-drive and geared powertrains in electric vehicles. Regenerative braking and energy recovery techniques in powertrains.		**CO1, CO2, CO4**
UNIT-III	**Charging Infrastructure and Energy Management Systems**	**Periods: 9**
Energy storage requirements in electric vehicle powertrains. Charging infrastructure—slow charging, fast charging, and wireless charging technologies. Energy management strategies in EV powertrains to optimize efficiency and extend battery life.		**CO3, CO5**
UNIT-IV	**Power Electronics and Motor Control for EV Powertrains**	**Periods: 9**
Role of power electronics in electric vehicle powertrains. DC-DC converters, inverters, and rectifiers in EV applications. Multi-level inverters and their control strategies. Motor control techniques—scalar control, vector control (Field-Oriented Control), and direct torque control for high-performance EV drivetrains. Efficiency optimization of power converters and loss minimization techniques in electric powertrains.		**CO2, CO3, CO4**
UNIT-V	**Advanced Trends in Electric Vehicle Powertrains**	**Periods: 9**
Smart powertrain technologies—Artificial Intelligence (AI) and Internet of Things (IoT) applications in powertrain optimization. Solid-state batteries and their impact on EV powertrain design. Case studies on Tesla, Lucid Air, and other cutting-edge EV powertrains. Future trends in powertrain electrification, including high-voltage architectures and ultra-fast charging solutions.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. M. Ehsani, Y. Gao, S. E. Gay, and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, 3rd EditionCRC Press, 2018.
2. James Larminie and John Lowry, Electric Vehicle Technology Explained, 2nd Edition, Wiley, 2012.
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd Edition, CRC Press, 2014
4. Ali Emadi, Advanced Electric Drive Vehicles, 1st Edition, CRC Press, 2014.
5. Sandeep Dhameja, Electric Vehicle Battery Systems, 1st Editio, Newnes, 2001.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	1	-	-	-	2	-	1		3	2	2
CO2	3	3	2	3	2	-	-	-	2	-	1		3	3	2
CO3	3	3	2	3	2	-	-	-	2	-	1		3	3	3
CO4	3	3	2	3	2	-	-	-	2	-	1		3	3	3
CO5	3	3	3	3	2	3	-	-	2	1	3		3	3	3

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Seventh**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUN108	**Electric Vehicle Diagnostics System**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course the students will be able to		
	CO1	Understand the overall maintenance of Electric vehicles and their types
	CO2	Analyse the Electric vehicle diagnostic devices and practical diagnostic system
	CO3	Discuss the diagnostics of electric drive train and sub-systems like battery, electrical machines, charging system and regenerative braking system.
	CO4	Gain the knowledge of chassis system maintenance and various diagnostic procedures related to brakes, steering and suspension systems.
	CO5	Analyze the maintenance and diagnostics of electrical systems including HVAC, airbags diagnostics, advanced fault diagnostics and remote diagnostics.

UNIT-I	**Introduction to Diagnostic System**	**Periods: 9**
Need for maintenance - types of maintenance: preventive and breakdown maintenance - requirements of maintenance - preparation of check lists – Inspection schedule - maintenance of records - log sheets and other forms - safety precautions in maintenance: General safety - tool safety - Diagnostic Techniques needs – diagnostic process - diagnostics on paper - mechanical diagnostic techniques - electrical diagnostic techniques (internal components and their systems) - Overview of diagnostics system in ECU - Diagnostic control system architecture in vehicles ECU, CAN with respect to the diagnostic system and its features - diagnostic protocols - Diagnostic standards (SAE, ISO, AIS)		**CO1**

UNIT-II	**Diagnostic Devices and Practical Diagnostics System**	**Periods: 9**
Scanning tools PC based - IOT and others - Basic equipment - Oscilloscopes - Scanners - ECU hardware tester - Gateway tester, ETAS, HIL for diagnostic system, Scan tool interface - ECU Programming and the ODX standard, Initial and reprogramming of ECU - End of Line (EOL) features - Flash programming in vehicle line production - Diagnostic programming process of ECU supplier – Diagnostic updates (OTA)for the vehicle software.		**CO2**

UNIT-III	**Electric Vehicle Systems related Diagnostics**	**Periods: 9**
Diagnostic architecture of the Electric vehicle motor control - Maintenance – Fault diagnosis and repair/replacement - Power electronic related diagnostic system faults and remedies - Electric Vehicle Drive Train diagnostic standards and scan tool - BMS related faults - Battery pack and Charging system diagnostic characteristics and architecture of working - types of faults in EV powertrain - Certification and standards for EV powertrain diagnostics process - HEV related EMS diagnostics features - ADAS related diagnostic testing standards and protocols.		**CO3**

UNIT-IV	**Chassis System Diagnostics**	**Periods: 9**
Chassis system diagnostic (brake, steering and suspension, TPMS etc.) – fault codes and types of faults in chassis system - Basic equipment - Oscilloscopes - Scanners - Fault code readers - Other components - Safety related (active and passive safety system) diagnostic protocols and types of fault codes and their remedies. Electronic components and circuits diagnosis - power distribution system faults - multiplexing - lighting - diagnosing auxiliary system faults - in car entertainment security and communication - body electrical system faults - diagnosing instruments cluster faults - HVAC diagnostics, steering control, wiper system diagnostics, Vehicle key system and immobilizer related diagnostics.		**CO4, CO5**

UNIT-V	**Electric Vehicle Maintenance and Service**	**Periods: 9**
Servicing and maintenance of Drive train system: clutch - gear box – transfer case - universal joints - CV joints - propeller shaft - final reduction -differential system, and rear axles. **Servicing and maintenance of chassis system:** Service and maintenance of brake - disc and drum brakes - front axle - steering systems - wheel alignment and suspension systems - Vehicle body maintenance - Steering system.		**CO1, CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Reference Books:

1. Tom Denton, "Advanced Automotive Fault Diagnosis: Automotive Technology: Vehicle Maintenance and Repair", 5th Edition; September 2020, Routledge.

2. Peter Subke, "Diagnostic Communication with Road-Vehicles and Non-Road Mobile Machinery", SAE International, 2019.
3. Marscholik C, Subke P. Road Vehicles: Diagnostic Communication: Technology and Applications. Laxmi Publications, Ltd ., 2009.
4. James Halderman, "Automotive Technology: Principles, Diagnosis, and Service", Pearson Automotive Series, 2019.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	-	-	-	-	1	1	2	3
CO2	3	3	3	3	3	3	-	-	-	-	1	1	2	3
CO3	3	3	3	3	2	3	-	-	-	-	1	1	2	2
CO4	3	3	3	3	3	3	-	-	-	-	1	1	2	3
CO5	3	3	3	3	2	3	-	-	-	-	1	0	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Ancillary Stream Elective – 3: POWER ENGINEERING

Department :**Electrical and Electronics Engineering**			Programme: **B.Tech.**					
Semester : **Fourth**			Course Category Code: **ANC**			Semester Exam Type: **TY**		
Course Code	**Course Name**		Periods / Week			Credit	Maximum Marks	
			L	T	P	C	CA	SE	TM
EEUN109	**Fundamentals of Power Systems**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome: At the end of the course the students will be able to	**CO1**	Able to explore the working principles of various types of Generating Power Stations and components							
	CO2	Gain knowledge about the impact of variable load on power systems							
	CO3	Able to explore the impact of economics on the power components and tariff structure in the restructured power market							
	CO4	Comprehend the fundamentals of economics of transmission system to meet the power system load							
	CO5	Gain knowledge about the technical challenges in Over head and Underground Transmission System							
UNIT-I	**Generating Stations**					**Periods: 9**			
Layout and Working principles of Thermal Power Station – Hydro Power Station – Nuclear Power Station – Solar and Wind Power Generation.									**CO1, CO2**
UNIT-II	**Variable load on Power Systems**					**Periods: 9**			
Structure of Electrical Power Systems – Variable Load on Power Station – Load Curves – Units Generated per Annum – Load Duration Curve – Demand and Diversity factors – Criteria for the selection of generation units – Base and Peak Loads – Method of meeting the power load – Interconnected Grid System.									**CO2**
UNIT-III	**Economics of Power Generation and Tariff**					**Periods: 9**			
Cost of Electrical Energy – Expressions for cost of Electrical Energy – Methods of determining depreciation – Importance of High Load factor – Tariff – Desirable characteristics of Tariff – Types of various customer Tariff – Power factor Improvement – Availability based Tariff – Time of Use Tariff.									**CO3, CO4**
UNIT-IV	**Electrical Supply Systems**					**Periods: 9**			
Typical AC power supply scheme – Comparison of D.C. and A.C. Transmission – Elements of Transmission Line – Economics of Power Transmission – Economic choice of conductor size and Transmission Voltage – Requirements of Satisfactory Electrical Supply.									**CO3, CO4**
UNIT-V	**Over Head Transmission Lines and Underground Cables**					**Periods: 9**			
Main components of overhead lines – conductor materials – Types of Line supports and insulators – methods of improving string efficiency – Corona effect – Sag in overhead lines – Construction and insulating materials of Underground cables – Laying procedure of Underground cables – Concepts of Grading in Underground cables.									**CO4, CO5**
Lecture Periods: 45	**Tutorial Periods:**		**Practical Periods:**			**Total Periods: 45**			

Reference Books:

1. V.K. Metha and Rohit Metha, " Principles of Power Systems", S. Chand Company, 2024.
2. Pedro Ponce et.al., " Power System Fundamentals" CRC Press, 2023.
3. C.L. Wadhwa, "Electrical Power Systems", New Age International Limited, 2020.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	1	2	-	-	1	3	1	2	3	2	1
CO2	3	3	3	3	3	2	-	1	1	2	2	2	2	1
CO3	3	3	2	3	2	2	-	2	1	2	2	3	2	1
CO4	3	3	3	3	2	3	-	2	1	2	2	3	2	2
CO5	3	3	3	3	3	-	-	2	3	2	3	3	2	1

Department :**Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **Fifth**			Course Category Code: **ANC**			Semester Exam Type: **TY**			
Course Code	**Course Name**		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUN110	**Power Markets and Exchanges**		3	-	-	3	40	60	100
Prerequisite									
Course Outcome: At the end of the course the students will be able to	**CO1**	Able to explore the structure and working principles of restructured power market.							
	CO2	Gain knowledge about the power market economics and philosophy.							
	CO3	Able to explore the structure and models of international power markets and pricing methodology.							
	CO4	Able to comprehend the concepts of transfer capability of transmission system and congestion management schemes.							
	CO5	Gain knowledge about the structure and operation of the Indian power market exchanges.							
UNIT-I	**Fundamentals of Restructuring of Power Industry**					**Periods: 9**			
Reasons for Restructuring - Fundamentals and structure of Restructured Power Market–Wheeling–Power exchange and pool markets-Structure and components of Independent System Operator (ISO)– role of ISO.									**CO1, CO2**
UNIT-II	**Power market Economics and Philosophy**					**Periods: 9**			
Customer behaviour – Supplier behaviour – Market equilibrium – Short run and Long run costs – various costs of production – Market models based on Contractual arrangements – comparison of various market models – Electricity vs commodities – Market architecture.									**CO1, CO2**
UNIT-III	**International Power Exchanges and Pricing**					**Periods: 9**			
Structure and operating principles of USA power markets – PJM, ERCOT, CAISO –NORDIC Power Market - Transmission pricing methods -Postage Stamp-Contract path-MW-mile– MVA mile– Distribution Factor method–Tracing method- Short run marginal cost (SRMC)–Generator Ramping and Opportunity Costs.									**CO3**
UNIT-IV	**Technical Challenges in Power market**					**Periods: 9**			
Role of transmission planning–Transmission Capacity–Total Transfer Capability (TTC) – Computational procedure - Margins–Available transfer capability (ATC)–Principles–Constraints-Methods to compute ATC - Concept of Congestion Management–Method store lieve the congestion-Inter and Intra zonal Congestion Management– Locational Marginal Pricing.									**CO4**
UNIT-V	**Indian Power Market**					**Periods: 9**			
Current Scenario – Regions–Salient features of Indian Electricity Act – Regulatory and Policy development in Indian power Sector – Availability based tariff – Necessity–Working Mechanism – Unscheduled Interchange Rate – Operation of various Indian Power Exchanges.									**CO4, CO5**
Lecture Periods: 45	**Tutorial Periods:**		**Practical Periods:**			**Total Periods: 45**			

Reference Books:

1. M. Shahidehpour and M. Alomoush, Restructuring Electrical Power Systems, Marcel Decker Inc., 2021.
2. M. Shahidehpour, H. Yamin and Z. Li, Market Operations in Electric Power Systems, John Wiley &Sons, Inc., 2022.
3. Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder, Operation of Restructured Power Systems, Kluwer Academic Publishers, 2011.
4. L. L. Lai, Power system Restructuring and Regulation, John Wiley sons, 2001.
5. Scholarly Transaction Papers, Utility and Power Exchange web sites.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	-	-	1	3	1	2	1	2	2
CO2	3	3	3	3	3	2	-	1	1	2	2	1	1	2
CO3	3	3	3	3	3	2	-	1	2	2	2	1	1	2
CO4	3	3	3	3	3	2	-	1	1	2	2	2	1	1
CO5	3	3	3	3	2	-	-	2	3	2	3	1	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**					
Semester : **Sixth**			Course Category Code: **ANC**			Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks	
			L	T	P	C	CA	SE	TM
EEUN111	**Smart System Automation**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome: At the end of the course the students will be able to	CO1	Introduce the smart system technologies and its role in real time applications.							
	CO2	Teach the architecture and requirements of Home Automation.							
	CO3	Provide an insight into smart appliances and energy management concepts.							
	CO4	Familiarize the design and needs of smart wearable devices.							
	CO5	Teach the basics of robotics and its role for automation.							
UNIT-I	**Introduction to Smart System**					**Periods: 9**			
Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.									**CO1, CO2**
UNIT-II	**Home Automation**					**Periods: 9**			
Home Automation – System Architecture - Essential Components- Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.									**CO1, CO2**
UNIT-III	**Smart Appliances and Energy Management**					**Periods: 9**			
Significance of smart appliances for energy management -Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.									**CO2, CO3**
UNIT-IV	**Smart Wearable Devices**					**Periods: 9**			
Body Area Networks - Sensors– communication protocol for Wearable devices- Application of Smart Wearable in Healthcare & Activity Monitoring.									**CO3, CO4**
UNIT-V	**Embedded Systems and Robotics**					**Periods: 9**			
Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.									**CO5**
Lecture Periods: 45		**Tutorial Periods: 0**	**Practical Periods: 0**			**Total Periods: 45**			

Reference Books:

1. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress , 2013.
2. James Momoh, Smart Grid Fundamentals of Design and Analysis, Wiley India Pvt. Ltd., 2018.
3. Krzysztof Iniewski, Smart Grid Infrastructure and Networking, McGraw Hill Education (India) Pvt. Ltd., 2014.
4. Robert Faludi, Wireless Sensor Networks, O'Reilly, 2011.
5. Stuart Borlase, Smart Grids: Infrastructure, Technology and Solutions, CRC Press Publication, 2013.
6. Bharat Modi, Anu Prakash & Yogesh Kumar, Fundamentals of Smart Grid Technology, S.K. Kataria & Sons, 2022.

CO-PO MAPPING

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO2	PSO3
CO1	2	3	2	3	2	-	-	-	2	-	1	2	-	-
CO2	2	3	3	3	2	-	-	-	2	-	1	2	-	-
CO3	3	3	3	3	2	-	-	-	2	-	1	3	-	-
CO4	3	3	3	3	2	-	-	-	2	-	1	3	-	-
CO5	3	2	2	3	2	-	-	-	2	-	1	3	-	-

Ancillary Stream Elective – 4: INDUSTRIAL INSTRUMENTATION
(Interdisciplinary Elective For students of EEE Department)

Department : **Electrical and Electronics Engineering**				Programme: **B.Tech.**				
Semester : **Fourth**				Course Category Code: **ANC**		Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUI101	**Sensors and Transducers**	**3**	**-**	**-**	**3**	**40**	**60**	**100**

Prerequisite:		
Course Outcome: At the end of the course the students will be able to	**CO1**	Know the basic concepts and fundamentals of Sensor and Transducer and their characteristics
	CO2	Study the different types of motion and optical based sensor.
	CO3	Analyze the force and pressure transducer of various types.
	CO4	Acquire the knowledge of principle of several types of temperature transducer.
	CO5	Know the working principle of different type of flow and level transducers.

UNIT-I	**Introduction**	**Periods: 9**	
Basics of Measurement – Classification of errors – Error analysis – Transducers- Electric transducer - Classification of transducers - Static and dynamic characteristics of transducers –Sensor calibration techniques – Sensor Output Signal Types.			**CO1**
UNIT-II	**Motion, optical Sensor**	**Periods: 9**	
Motion Sensors – Potentiometers, Resistive, Inductive, Capacitive, LVDT – RVDT – Resolver, Encoders Types– Opto - electronic transducer –types – photo voltaic cell photo conductive cell phot diode -Accelerometer– Magneto strictive transducer.			**CO1 CO2**
UNIT-III	**Force and Pressure transducer**	**Periods: 9**	
Strain Gauge – Types of strain gauges Pressure Sensors –types, Diaphragm, Bellows, C-tube - Piezoelectric transducer – Hall Effect Transducer– measurement of vibration, Seismic transducer - Measurement of sound using microphone – types of microphones			**CO1 CO3**
UNIT-IV	**Temperature transducer**	**Periods: 9**	
Temperature transducer types –Fluid expansion and metal expansion – Thermometer, bimetallic strip Thermistor, RTD, Thermocouple, IC, Pyrometer – types - infrared pyrometer and optical pyrometer Measurement of Humidity - Hygrometer			**CO1 CO4**
UNIT-V	**Flow and level transducer**	**Periods: 9**	
Flow transducer – types - Electromagnetic flow meter. Orifice plate, venturi tube, rotameter, anemometer, nozzle plate. Measurement of Liquid level- types- electrical method and float, gamma rays & ultrasonic method.			**CO1 CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods:45**

Reference Books:

1. A.K. Sawhney, A course of Electrical & Electronics Measurements & Instrumentation, Dhanpat Rai & sons, 2010.
2. Arun K. Ghosh, Introduction to Measurements and Instrumentation, Prentice Hall of India private limited, 2012.
3. R.K. Rajput, Electrical and Electronic Measurement and Instrumentation, S. Chand and Co. Pvt ltd,2016.
4. John P. Bentley, Principles of Measurement System, Addison Wesley Longman Pvt. Ltd., 2002.
5. G.S. Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw Hill, 2001.
6. D.V.S. Moorthy, Transducers & Instrumentation, Prentice Hall of India, 2008.

CO-PO MAPPING

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	-	-	-	2	2	1
CO2	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO3	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO4	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO5	2	2	2	2	1	2	-	-	-	-	2	2	2	1

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**					
Semester : **Fifth**			Course Category Code: **ANC**			Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks	
			L	T	P	C	CA	SE	TM
EEUI102	**Industrial Automation**		**3**	**-**	**-**	**3**	**40**	**60**	**100**
Prerequisite:								
Course Outcome: At the end of the course the students will be able to	**CO1**	Analyse the basic concepts of Industrial Automation						
	CO2	Study the different components of Automation Industry						
	CO3	Gain knowledge in Programmable Logic Controller						
	CO4	Acquire knowledge in the DCS and SCADA system						
	CO5	Know the fundamentals of the Robotics and safety						
UNIT-I I	**Introduction**					**Periods: 9**		
Automation overview – requirement of automation systems – architecture of industrial automation system – Levels of Automation-basic elements of an automated system – industrial bus systems: modbus and profibus.								**CO1**
UNIT-II	**Automation Components**					**Periods: 9**		
Sensors for temperature, pressure, force, displacement, flow, level, Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.								**CO1 CO2**
UNIT-III	**Programmable logic controllers**					**Periods: 9**		
Programmable controllers, Programmable logic controllers, Analog-digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantages of using PLC for Industrial automation, and Application of PLC in industries.								**CO3**
UNIT-IV	**DCS and SCADA**					**Periods: 9**		
Overview of DCS, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS. Introduction to Supervisory Control and Data Acquisition Systems (SCADA)– SCADA and HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software								**CO3 CO4**
UNIT-V	**Robotics and safety in Automation**					**Periods: 9**		
Robotics in Industrial Automation- Introduction – Basics of Robot programming and exercise – Safety in Industrial Automation – Importance of Safety – Safety standard and regulation –Understanding Industry 4.0 – Future Trends – Key concepts and Technologies – IOT in Industrial Automation								**CO1 CO5**
Lecture Periods: 45	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 45**		

Reference Books:

1. Industrial Instrumentation, Control and Automation S. Mukhopadhyay, S.Sen and A.K. Deb, Jaico Publishing House, 2013
2. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
3. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw-Hill, New York, 2016.
4. Krishna Kant, “Computer-Based Industrial Control”, 2nd Edition, Prentice Hall, New Delhi, 2011.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	-	1	-	1	-	-	-	-	-	-	2	2	1
CO2	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO3	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO4	2	2	2	2	1	2	-	-	-	-	2	2	2	1
CO5	2	2	2	1	1	2	-	-	-	-	2	2	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	**Course Name**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUI103	**Internet of Things**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course the students will be able to		
	CO1	Explore the architecture, functional blocks, and enabling technologies of IoT**,** including sensing, actuation, and communication interfaces.
	CO2	Analyze various wired and wireless communication technologies such as RFID, NFC, ZigBee, Bluetooth, and 6LoWPAN for IoT applications.
	CO3	Explore internet protocols and networking standards used in IoT, including OSI model, network topologies, and proprietary protocols.
	CO4	Investigate IoT data analytics and cloud computing technologies, focusing on data collection, processing, storage, and cloud-based services.
	CO5	Evaluate Industrial IoT (IIoT) architectures and communication protocols, such as OPC and MQTT, while addressing security and data integrity challenges.

UNIT-I	**Overview of Internet of Things**	**Periods: 9**
Introduction to Internet of Things - Definition of Internet of Things- IoT functional blocks - the Edge, Cloud and the Application Development, IoT enabling Technologies, Architecture of IoT, IoT layers and levels, Anatomy of the Thing, sensing and actuation devices, Input and Output Communication interfaces - UART, SPI, I2C, and CAN.		**CO1, CO5**
UNIT-II	**Communication technologies**	**Periods: 9**
Wired and Wireless solutions, RFID (eg. ISO 18000 6c EPC class 1 Gen2), NFC, IEEE 802.11 (WLAN), IEEE 802.15.4(ZigBee), IEEE 802.15.1(Bluetooth), Multihop, IETF Low power Wireless Personal Area Networks (6LoWPAN), Machine to Machine (M2M) and traditional IP technologies such as IPv4 and IPv6 Wireless Sensor/Mesh Networks.		**CO1, CO2**
UNIT-III	**Internet Protocols**	**Periods: 9**
Understanding Internet Protocols - Simplified OSI Model, Network Topologies and standards, Proprietary Protocols, SimpliciTI, Networking Design – Push, Pull and Polling, Network APIs.		**CO2, CO3**
UNIT-IV	**IoT Data Analytics**	**Periods: 9**
IoT Cloud, Data handling and Analytics - IoT Data Collection, Processing IoT Data, Cloud Storage, Cloud computing, Cloud computing services, IoT Cloud Platforms, IoT Specific Challenges and Opportunities.		**CO3, CO4**
UNIT-V	**Industrial IoT**	**Periods: 9**
Introduction – Standard industrial setup – Architecture of IIoT – Components of IIoT – Machine to Gateway Communication – Components of a Gateway – Communication Protocols in IIoT – OPC and MQTT and their Architecture- OPC vs MQTT – Security and Data Integrity.		**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Reference Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, First Edition, Pearson Education, 2017.
2. Arshdeep Bagha and Vijay Madisetti, Internet of Things - A Hands-on Approach, Universities Press (India), 2017.
3. Rajkumar Buyya and Amir Vahid Dastjerdi, Internet of Things– Principles and Paradigms, Morgan Kauffman, 2016.
4. Pethuru Raj, Anupama C. Raman, The Internet of Things – Enabling Technologies, Platforms and Use Cases, CRC Press, 2017.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3	3	3	1	-	2	-	2	2	2	2	1
CO2	2	3	3	3	3	1	-	2	-	2	2	2	2	1
CO3	2	3	3	3	3	1	-	2	-	2	2	2	2	1
CO4	2	3	3	3	3	1	-	2	-	2	2	2	2	1
CO5	2	3	3	3	3	1	-	2	-	2	2	2	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**					
Semester : **Seventh**			Course Category Code: **ANC**			Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks	
			L	T	P	C	CA	SE	TM
EEUI104	**Industry 4.0**		3	-	-	3	40	60	100
Prerequisite:								
Course Outcome: At the end of the course the students will be able to	**CO1**	Understand the need of industry 4.0 and interpret the architecture of IoT and its protocols						
	CO2	Realise the use of Big Data and Cloud computing architecture in IIoT						
	CO3	Analyse the uses of cloud computing and data analytics in Industry 4.0						
	CO4	Evaluate the techniques used in Digital manufacturing system						
	CO5	Apply the knowledge of IoT, Cloud computing and Cyber security for case studies of Industry 4.0 standards.						
UNIT-I	**IoT in Industrial Revolution**					**Periods: 9**		
Introduction to Industry 4.0 - Digitalization and the networked economy - Basics of Internet of Things (IoT) and Network protocol - IoT Architecture and its standards - Industry Internet of Things (IIoT) - Need of sustainability assessment of Industries – Lean Production and Smart factory - Introduction to sensors and actuators – Next generation sensors.								**CO1**
UNIT-II	**Big data and Cyber Security In Industry 4.0**					**Periods: 9**		
Cyber Physical Systems (CPS) – Features - Role of AI in Industry 4.0 - Need of Big Data in IIoT - Big Data analytics – Data Science in IIoT and Data centered network - Data management using Hadoop - Cyber security in Industry 4.0 - Components - Threats and Awareness - Security issues within Industry 4.0 network.								**CO2, CO3**
UNIT-III	**Cloud Computing for IoT**					**Periods: 9**		
Introduction to Cloud computing - Cloud computing service options - Cloud deployment models - Cloud virtualization - Types of Hypervisors - Fog computing architecture in IIoT - Cloud 9marketplace and Cloud providers - IoT Gateway, IoT Edge, and its programming.								**CO2, CO3**
UNIT-IV	**Digital Manufacturing**					**Periods: 9**		
Introduction to Digital manufacturing - Architecture of Digital manufacturing - Digital Twin technology for smart manufacturing system – Road map to success in Digital Manufacturing -Identification of current situation in Industry – Perform Self-study – attain future goal with in Digital Manufacturing and Design (DMD).model – Intelligent Machining - concept, elements and benefits.								**CO4**
UNIT-V	**Applications and Case Studies**					**Periods: 9**		
Application: Assembly sectors in Factories, Inventory and Quality control in Industries, Industrial security and Safety Management and Health care sectors. Case Study: Processing and packing industries and Automobile manufacturing sectors.								**CO5**
Lecture Periods: 45	**Tutorial Periods:**		**Practical Periods:**			**Total Periods: 45**		

Reference Books:

1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC press, 2021.
2. Hamilton Ortiz J, “Industry 4.0 - Current Status and Future Trends”, 2020, available from: http://dx.doi.org/10.5772/intechopen.86000.
3. Cheng FT, “Industry 4.1: Intelligent Manufacturing with Zero Defects”, John Wiley & Sons, 2021.
4. Bernabe J B, Skarmeta A, “Introducing the challenges in cyber security and privacy-the European Research Landscape, River Publishers, 2022.
5. Buyya R, Srirama S N, “Fog and edge computing: principles and paradigms”, John Wiley & Sons; 2019.
6. Kurfess T R, Saldana C, Saleeby K, Dezfouli M P, “A review of modern communication technologies for digital manufacturing processes in industry 4.0”, Vol.142, No.11, Journal of Manufacturing Science and Engineering. 2020.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	2	-	1	-	-	-	-	-	-	2	-
CO2	1	2	3	-	-	-	-	-	-	-	-	2	-
CO3	1	3	-	-	2	-	-	-	-	-	-	-	2
CO4	1	-	2	-	-	-	-	-	-	-	-	2	-
CO5	1	-	-	-	-	3	2	-	-	-	-	-	2

Score: 3 – High; 2 – Medium; 1 – Low

Ancillary Stream – 5: COMPUTER NETWORKS AND PROBLEM SOLVING
(Interdisciplinary Elective For students of EEE Department)

<table>
<tr><td colspan="3">Department : Electrical and Electronics Engineering</td><td colspan="5">Programme: B.Tech.</td></tr>
<tr><td colspan="3">Semester : Fifth</td><td colspan="3">Course Category Code: ANC</td><td colspan="2">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">EEUI105</td><td rowspan="2">Optimization Techniques</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="2">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td></td><td></td><td>2</td><td>1</td><td>-</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="7">Differential and Integral Calculus, Vector Algebra and Matrix analysis.</td></tr>
<tr><td rowspan="5">Course Outcome:
At the end of the course, the students will be able</td><td>CO1</td><td colspan="6">To interpret the concept of classical optimization techniques, the optimization problem statement, decision variables and constraints.</td></tr>
<tr><td>CO2</td><td colspan="6">To formulate an optimization problem as linear programming problem and solve using simplex method and its variants.</td></tr>
<tr><td>CO3</td><td colspan="6">To solve one dimensional optimization problems using elimination methods and to find solution to unconstrained nonlinear optimization problems using search and gradient methods.</td></tr>
<tr><td>CO4</td><td colspan="6">To solve constrained nonlinear optimization problems using direct and indirect methods.</td></tr>
<tr><td>CO5</td><td colspan="6">To comprehend and solve dynamic programming optimization and integer programming optimization problems using standard techniques.</td></tr>
<tr><td>UNIT-I</td><td colspan="5">Classical Optimization Problems and Techniques</td><td colspan="2">Periods: 9</td></tr>
<tr><td colspan="6">Statement of an optimization problem – classification of optimization problems – Single variable optimization problem – multivariable optimization problem without constraints and with equality constraints – solution techniques using Lagrange multipliers – solution to multivariable optimization problem with inequality constraints – Kuhn-Tucker conditions.</td><td colspan="2">CO1</td></tr>
<tr><td>UNIT-II</td><td colspan="5">Linear Programming Problems</td><td colspan="2">Periods: 9</td></tr>
<tr><td colspan="6">Introduction to Linear Programming method of optimization – Standard form of a linear programming problem – Elementary graphical method for solving two-variable linear programming optimization problem – Basic theorems of linear programming – Simplex method of solving linear programming problem – Motivation – Simplex algorithm – Two phases of simplex method – Revised Simplex method and Duality in linear programming.</td><td colspan="2">CO1, CO2</td></tr>
<tr><td>UNIT-III</td><td colspan="5">Unconstrained Nonlinear Programming Problems</td><td colspan="2">Periods: 9</td></tr>
<tr><td colspan="6">One-dimensional Minimization Problems: – Unimodal objective function – Elimination methods: Exhaustive search method, Dichotomous search – Interval halving method – Fibonacci method – Golden section method.
Unconstrained Minimization Problem: Direct search methods: Random search and Grid search methods – Indirect search (Descent) methods: Gradient method – Steepest descent (Cauchy) method – Conjugate gradient (Fletcher-Reeves) method – Newton method.</td><td colspan="2">CO2, CO3</td></tr>
<tr><td>UNIT-IV</td><td colspan="5">Constrained Nonlinear Programming Problems</td><td colspan="2">Periods: 9</td></tr>
<tr><td colspan="6">Characteristics of a constrained optimization problem – Constrained optimization techniques – Direct methods: Sequential Linear Programming (SLP) and Sequential Quadratic Programming. Indirect methods: Interior and Exterior penalty function methods, Lagrange multiplier method.</td><td colspan="2">CO3, CO4</td></tr>
<tr><td>UNIT-V</td><td colspan="5">Dynamic and Integer Programming Problems</td><td colspan="2">Periods: 9</td></tr>
<tr><td colspan="6">Dynamic Programming: Multistage decision processes – Concept of sub-optimization and the principle of optimality – Computational procedure in Dynamic Programming – Conversion of a final value problem into initial value problem.
Integer Linear Programming Problem – Graphical solution and Gomory's cutting plane method.</td><td colspan="2">CO1, CO2, CO5</td></tr>
<tr><td colspan="2">Lecture Periods: 30</td><td colspan="2">Tutorial Periods: 15</td><td colspan="2">Practical Periods: 0</td><td colspan="2">Total Periods: 45</td></tr>
<tr><td colspan="8">Reference Books:
1. S.S. Rao, "Engineering Optimization; Theory and Practice", Revised 3rd Edition, New Age International Publishers, New Delhi, 2013.
2. Hillier and Lieberman "Introduction to Operations Research", TMH, 2000.
3. R. Panneerselvam, "Operations Research", PHI, 2006.</td></tr>
</table>

4. Hamdy A Taha, “Operations Research –An Introduction”, Prentice Hall India, 2003.
5. Philips, Ravindran and Solberg, “Operations Research”, John Wiley, 2002.
6. Ronald L. Rardin, “Optimization in Operation Research” Pearson Education Pvt. Ltd. New Delhi, 2005.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	2	-	-	-	-	-	-	3	2	1
CO2	3	3	3	3	1	-	-	-	-	-	-	3	2	1
CO3	3	3	3	3	3	-	-	-	-	-	-	3	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	3	2	1
CO5	3	3	3	3	3	-	-	-	-	-	-	3	2	1

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Sixth**		Course Category Code: **ANC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUI106	**Soft Computing**	3	-	-	3	40	60	100
Prerequisite:	Electric Circuit Analysis, Electrical Machines							

Course Outcome: At the end of the course the students will be able to		
	CO1	Gain the basic knowledge of Fuzzy logic and Neural network concepts
	CO2	Understand the differences between AI techniques and meta-heuristic algorithms
	CO3	Acquire the knowledge of simple genetic algorithm and swarm intelligence based techniques
	CO4	Understand the difference between algorithmic implementation of GA and swarm intelligence based techniques for solving simple optimization problems
	CO5	Analyse the applications of soft computing techniques for single and multi-objective optimization problems

UNIT-I	**Fuzzy Logic**	**Periods: 9**
Introduction - Fuzzy Logic - Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Operations on Fuzzy Relations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems.		**CO1**
UNIT-II	**Neural Networks**	**Periods: 9**
Supervised Learning Neural Networks – Perceptrons – Back propagation -Multilayer Perceptrons – Unsupervised Learning Neural Networks – Kohonen Self-Organizing Networks.		**CO1, CO2**
UNIT-III	**Genetic Algorithms (GA)**	**Periods: 9**
Introduction to meta heuristics – Simple genetic algorithm – Flow chart – objective function and fitness function – Selection – Crossover – Mutation – Elitism – Necessity of optimal parameter selection – Stopping criterion - Algorithmic Implementation of GA.		**CO3, CO4**
UNIT-IV	**Swarm Intelligence based Algorithms**	**Periods: 9**
Introduction to swarm intelligence, PSO flow chart – Operators - Position and velocity update equations– Competition and selection – Ant Colony Optimization algorithm – Bacteria Foraging Algorithm - Artificial Bee Colony Algorithm – Algorithmic Implementation		**CO4**
UNIT-V	**Applications of Soft computing Techniques**	**Periods: 9**
Neuro – Fuzzy applications – Simple Genetic algorithm applications - PSO applications – ACO applications – Introduction to Hybrid evolutionary algorithms – Multi-objective optimization by evolutionary algorithms with application.		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Reference Books:

1. Sandhya Bansal, Rajiv Goel, "Fundamentals of Soft Computing", Notion Press, 2020.
2. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003.
3. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, Third Edition, Wiley India Pvt Ltd, 2019.
4. Z Michalewicz, Genetic Algorithms + Data Structures = Evolution Programs (3rd edition), Springer-Verlag, Berlin, 2007.
5. D E Goldberg, Genetic Algorithms in Search, Optimisation & Machine Learning, Addison Wesley, 2003.
6. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2007.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-	1	2	0
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	1
CO3	2	3	3	3	3	-	-	-	-	-	-	1	1	1
CO4	2	3	3	3	3	-	-	-	-	-	-	1	1	1
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**			Programme : **B.Tech.(EEE)**						
Semester : **Seventh**			Course Category Code: **ANC**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUI107	**Computer Networks**		3	-	-	3	40	60	100
Prerequisite:									
Course Outcome: At the end of the course the students will be able to	**CO1**	Able to provide insight about networks, topologies, and the key concepts							
	CO2	Able to gain comprehensive knowledge about the layered communication architectures (OSI and TCP/IP) and its functionalities							
	CO3	Able to understand the principles, key protocols, design issues, and significance of each layer in ISO and TCP/IP							
	CO4	Able to know the basic concepts of network security and its various security issues related with each layer							
UNIT-I	**Introduction**					**Periods: 9**			
Network applications, network hardware, network software, reference models: OSI, TCP/IP, Internet, Connection oriented network - X.25, frame relay. The Physical Layer-Theoretical basis for communication, guided transmission media, wireless transmission, the public switched telephone networks, mobile telephone system.									**CO1**
UNIT-II	**The Data Link Layer**					**Periods: 9**			
Design issues, error detection and correction, elementary data link protocols, sliding window protocols, example data link protocols - HDLC, the data link layer in the internet. THE MEDIUM ACCESS SUBLAYER: Channel allocations problem, multiple access protocols, Ethernet, Data Link Layer switching, Wireless LAN, Broadband Wireless, Bluetooth									**CO1, CO4**
UNIT-III	**The Network Layer**					**Periods: 9**			
Network layer design issues, routing algorithms, Congestion control algorithms, Internetworking, the network layer in the internet (IPv4 and IPv6), Quality of Service.									**CO1, CO4**
UNIT-IV	**The Transport Layer**					**Periods: 9**			
Transport service, elements of transport protocol, Simple Transport Protocol, Internet transport layer protocols: UDP and TCP.									**CO1, CO4**
UNIT-V	**Application Layer and Protocols**					**Periods: 9**			
Domain name system, electronic mail, World Wide Web: architectural overview, dynamic web document and http. Simple Network Management Protocol, File Transfer Protocol, Simple Mail Transfer Protocol, Telnet.									**CO2. CO3**
Lecture Periods: 45	**Tutorial Periods: 0**		**Practical Periods: 0**			**Total Periods: 45**			
Reference Books:									
1. A. S. Tanenbaum (2003), Computer Networks, 4th edition, Pearson Education/ PHI, New Delhi, India. 2. Behrouz A. Forouzan (2006), Data communication and Networking, 4th Edition, Mc Graw-Hill, India. 3. Kurose, Ross (2010), Computer Networking: A top-down approach, Pearson Education, India.									

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	3	-	-	3	-	3	1	1	2
CO2	3	3	3	3	2	2	-	-	2	-	1	1	1	1
CO3	3	3	3	3	1	2	-	-	2	-	1	2	2	2
CO4	2	3	3	3	3	3	-	-	2	-	3	1	1	1

Score: 3 – High; 2 – Medium; 1 – Low

Annexure IV

Syllabi of Courses offered to Other Departments by the Department of Electrical and Electronics Engineering

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech. (MT)**						
Semester : **Third**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC129	**Analog and Digital Electronics**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome: At the end of the course student will be able to	**CO1**	Analyze the characteristics and applications of diodes and transistors, including their role in voltage regulation and switching circuits.
	CO2	Apply operational amplifier principles to design amplifiers, waveform generators, and instrumentation circuits.
	CO3	Implement analog signal processing circuits, such as active filters, multivibrators, and data converters, using op-amps and 555 timers.
	CO4	Develop combinational logic circuits using Boolean algebra, Karnaugh maps, and logic gates for arithmetic and data processing applications.
	CO5	**Design and analyze sequential circuits**, including flip-flops, counters, and shift registers, for memory and control applications.

UNIT-I	**Diode and BJT Characteristics**	**Periods: 9**	
PN junction diode - V-I characteristics, Junction diode models, Junction diode as switch, Diode specifications, Circuit applications of diodes , Zener diode- Characteristics – zener diode as Voltage Regulator. Bipolar Junction Transistor- construction and working in CB and CE configurations			**CO1**
UNIT-II	**Operational Amplifiers**	**Periods: 9**	
Block diagram of operational amplifiers (op-amp)-Differential amplifier - Characteristics of op-amp – ideal and practical op-amp, Open-loop-comparator, zero crossing detector, Feedback configurations- Inverting amplifier, Non-inverting amplifier, Voltage follower, adder and subtractor circuits, differentiator and integrator circuits – Instrumentation amplifier			**CO2**
UNIT-III	**Operational Amplifier Applications**	**Periods: 9**	
Comparator - Schmitt trigger -Square wave generator - Triangular wave generator, DAC and ADC characteristics, Active filters - Low Pass Filter - High Pass Filter - Band Pass Filter - Band elimination Filter Multivibrators -Astable, Monostable and Bistable multivibrator, 555 timers – astable multivibarator			**CO2, CO3**
UNIT-IV	**Digital System and Combinational Circuits**	**Periods: 9**	
Binary arithmetic – Boolean algebra and logic gates – De' Morgan theorems – Universal gates – Simplification of Boolean expressions. Karnaugh maps and simplification of logical expressions using K-Map– Combinational Logic: Half adder, full adder, subtractor circuits. Magnitude comparator, Multiplexer and demultiplexer, decoder, encoder.			**CO4**
UNIT-V	**Sequential Circuits**	**Periods: 9**	
Set-Reset laches, D-flip-flop, R-S flip-flop, J-K Flip-flop, T flip-flop. Design of counters using Flip-flops– Synchronous, asynchronous, Up/Down counters, decade counter, ring counter, Johnson counter–Shift registers - Parallel/serial and bi-directional shift registers.			**CO4, CO5**

Lecture Periods: 45	**Tutorial Periods: 0**	**Practical Periods: 0**	**Total Periods: 45**

Reference Books:

1. Boylestad RL, Nashelsky L, Electronic Devices and Circuit theory, Pearson Education, Eleventh edition, 2015.
2. Morris Mano, Digital design, PHI learning, Sixth Edition, 2018.
3. D Roy Choudhury, Shail B Jain, Linear Integrated Circuits, New Age International Publications, 2021

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	-	-	-	2	-	1	2	1	-
CO2	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO3	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO4	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO5	2	3	3	3	3	-	-	-	2	-	1	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low

Department :**Electrical and Electronics Engineering**		Programme: **B.Tech. (MT)**						
Semester : **Third**		Course Category Code: **PCC**				Semester Exam Type: **LB**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC130	**Analog and Digital Electronics Laboratory**	-	-	3	1.5	40	60	100
Prerequisite:								

Course Outcome At the end of the course student will be able to		
	CO1	Conduct experiments to derive and validate the characteristics of electronic devices and circuits
	CO2	Design, construct and test operational amplifier circuits
	CO3	Conduct experiment to verify the basic operations of gates and flip flops
	CO4	Design, Construct and test different digital logic circuits

UNIT-I	**Diode and BJT**	
1. Characteristics of PN Junction Diode and Zener Diode 2. Diode circuits(Clippers and Clampers) 3. Characteristics of BJT in Common Emitter Configuration		**CO1**
UNIT-II	**Operational Amplifiers**	
4. Inverting and non-inverting amplifiers 5. Summing and difference amplifier 6. Instrumentation amplifier		**CO1, CO2**
UNIT-III	**Combinational logic circuits**	
7. Study of logic gates, verification of De-Morgan's laws and realization of basic gates using universal gates. 8. Combinational logic circuits – full and half Adder/Subtractor. 9. Encoder and decoder using logic gates. 10. Multiplexer and de-multiplexer using logic gates.		**CO3, CO4**
UNIT-IV	**Sequential logic circuits**	**Periods:**
11. Realization of R-S, D, J-K and T flip-flops using logic gates. 12. Sequential logic circuits: Up/Down counters/MOD-10 counters using IC 7476 (J-K Mater-Slave Flip flop). 13. Ring counter and Johnson counter using IC7476. 14. Decade counter IC7490		**CO3, CO4**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods:45**	**Total Periods: 45**

Reference Books:

1. Boylestad RL, Nashelsky L, Electronic Devices & Circuit theory, Pearson Education, Eleventh edition, 2015.
2. Morris Mano, Digital design, PHI learning, Sixth Edition,2018.
3. D Roy Choudhury, Shail B Jain, Linear Integrated Circuits, New Age International Publications, 2021

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	1	-	-	2	-	-	-
CO2	3	3	2	3	2	-	-	2	-	-	-
CO3	3	2	1	1	1	-	-	2	-	-	-
CO4	3	3	2	3	2	-	-	2	-	-	2

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme : **B.Tech. (MT)**						
Semester : **Fifth**		Course Category Code: **ESC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC131	**Electric Motors and Power Electronics in Motion Control**	3	-	-	3	40	60	100
Prerequisite:	**Analog and Digital Electronics**							

Course Outcome: At the end of the course student will be able to		
	CO1	Able to explain the principles of DC, AC and special electric motors, and select them based on standard specifications
	CO2	Able to understand the working of power semiconductor devices and power modulator circuits
	CO3	Able to understand the necessity of electric motors and power electronic circuits in motion control
	CO4	Able to articulate the concept of voltage source inversion, and control of induction and special electric motors using voltage source inverters
	CO5	Able to recognise different types of loads in industrial processes and develop electric drive-controlled actuations

UNIT-I	**DC Motors**	**Periods: 9**

Principle of Electric Motors-Electromechnical energy conversion, Construction of DC motor, Torque Equation; Types of Motors-Connection, Basic equations, Electrical and mechanical characteristics; Speed Control; Braking Methods; Losses; Industrial Applications. Motor Nameplates-Interpretation of information, Standards; Mounting and Enclosures, IP rating. Interpretation of IS:2253.	**CO1**

UNIT-II	**AC Motors**	**Periods: 9**

Three Phase Induction Motor: Squirrel Cage Induction Motor- Construction, Establishment of rotating magnetic field; Electrical and Mechanical Characteristics, Speed Control; Braking Methods; Losses and Efficiency, Industrial Applications. Interpretation of IS 12615:2018. **Single Phase Induction Motor:** Basic Construction, Reason for not Self-starting- Rotating Versus Alternating Magnetic fields, Working of capacitor start induction run and Capacitor start capacitor run types; Electrical and Mechanical Characteristics; Industrial Applications.	**CO1**

UNIT-III	**Power Electronic Circuits for Motors and Actuators**	**Periods: 9**

Power Semiconductor Switches: Signal devices Vs Power Devices, Ideal switch; Power Diode, SCR and IGBT-Construction, Working, Static Characteristics. **Single Phase Fully Controlled Rectifies:** Power circuit, waveforms, mode diagrams and output voltage relations in continuous (with ripple) load currents. Working of Dual converter-Quadrants. Speed control of DC motor using single phase fully controlled rectifier and Dual converter. **Voltage Source Inverter:** Single Phase H Bridge VSI- Square wave operation, Harmonic analysis; Necessity of PWM; SPWM-Voltage control and Harmonic spectrum. Three Phase VSI- Six step operation in 180^0 conduction modes using fundamental switching. Stator voltage and V/f controls of three phase induction motor using three phase SPWM VSI. Impact of Harmonics on Torque Quality.	**CO2, CO4**

UNIT-IV	**Special Electric Motors and Control**	**Periods: 9**

DC and AC Servo motors- Constructional changes and arriving servo features. Stepper Motor- Types, Construction and principle of operation, Modes of excitation, Drive system, Logic sequencer; Position control by servo and stepper motors. Linear Induction motor-Construction, Drive and control; A.C Commutator Motor. Industrial Applications of special Electric Motors.	**CO1, CO3**

UNIT-V	**Electric Drives in Motoring and Actuation**	**Periods: 9**

Elements of Electric Drives- Closed loop control of DC and AC motors; Mechanical characteristics of loads, Components of load torques, Class of motor duty, Group and Individual Drives; Dynamics of Motor and Load Combination - Equivalent system. Four Quadrant working of motors. Applications in Manufacturing Process and Actuation- Required motion control actions in industries; Motion Control Drive Systems- Block diagram level understanding of Rolling mill, Textile mill, Traction, Machining processes, Agitators, Electric Vehicles, Conveyors.	**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods: Nil**	**Total Periods: 45**

Reference Books:

1. J.B. Gupta, *Theory and Performance of Electrical Machines*, S.K. Kataria & Sons, 2013
2. R.K. Rajput, *A Textbook Of Electrical Machines*, Laxmi Publications, 2016
3. P.S. Bimbhra, *Power Electronics*, Khanna Publishers, New Delhi, 2025.
4. Bogdan M. Wilamowski and J. David Irwin, *The Industrial Electronics Handbook-Power Electronics and motor drives*, CRC Press, New York, Second edition, 2011.
5. Steve Senty, *Motor Control Fundamentals,* Delmar, Cengage Learning, 2013.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	PSO3
CO1	3	3	3	3	2	3	-	-	3	-	3		1	1	2
CO2	3	2	2	3	2	3	-	-	2	-	3		1	1	1
CO3	3	2	3	3	2	3	-	-	3	-	3		2	2	2
CO4	3	2	2	3	2	3	-	-	2	-	3		1	1	1
CO5	3	3	3	3	3	3	-	-	3	-	3		3	3	3
CO6	-	-	-	-	-	-	-	-	-	-	-				

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech. (CSE)**						
Semester : **Fourth**		Course Category Code: **ASC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUCASC	**Soft Computing Techniques**	3	-	-	3	40	60	100
Prerequisite:								

Course Outcome	**CO1**	Acquire the basic knowledge of Fuzzy logic and Neural network concepts
	CO2	Understand the differences between AI techniques and meta-heuristic algorithms
	CO3	Acquire the knowledge of simple genetic algorithm and swarm intelligence based techniques
	CO4	Understand the difference between algorithmic implementation of GA and swarm intelligence based techniques for solving simple optimization problems
	CO5	Analyse the applications of soft computing techniques for single and multi-objective optimization problems

UNIT-I	**Fuzzy Logic**	**Periods: 9**
Introduction - Fuzzy Logic - Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Operations on Fuzzy Relations, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems.		**CO1**
UNIT-II	**Neural Networks**	**Periods: 9**
Supervised Learning Neural Networks – Perceptrons – Back propagation -Multilayer Perceptrons – Unsupervised Learning Neural Networks – Kohonen Self-Organizing Networks.		**CO1, CO2**
UNIT-III	**Genetic Algorithms (GA)**	**Periods: 9**
Introduction to meta heuristics – Simple genetic algorithm – Flow chart – objective function and fitness function – Selection – Crossover – Mutation – Elitism – Necessity of optimal parameter selection – Stopping criterion - Algorithmic Implementation of GA.		**CO2, CO3**
UNIT-IV	**Swarm Intelligence**	**Periods: 9**
Introduction to swarm intelligence, PSO flow chart – Operators - Position and velocity update equations– Competition and selection – Ant Colony optimization – Artificial Bee Colony optimization – Algorithmic implementation.		**CO3, CO4**
UNIT-V	**Applications**	**Periods: 9**
Neuro – Fuzzy applications - Genetic algorithm applications - PSO applications - Application of Hybrid evolutionary algorithms – Applications of Multi-objective evolutionary algorithms.		**CO5**

Lecture Periods: 45	**Tutorial Periods:**	**Practical Periods:**	**Total Periods: 45**

Reference Books:

1. S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003.
2. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, Third Edition, Wiley India Pvt Ltd, 2019.
3. Z Michalewicz, Genetic Algorithms + Data Structures = Evolution Programs (3rd edition), Springer-Verlag, Berlin, 2007.
4. D E Goldberg, Genetic Algorithms in Search, Optimisation & Machine Learning, Addison Wesley, 2003.
5. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2007.
6. Sandhya Bansal, Rajiv Goel, “Fundamentals of Soft Computing”, Notion Press, 2020.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-	1	2	0
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	1
CO3	2	3	3	3	3	-	-	-	-	-	-	1	1	1
CO4	2	3	3	3	3	-	-	-	-	-	-	1	1	1
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	2

Score: 3 – High; 2 – Medium; 1 – Low

Annexure V

Syllabi of First Year Courses by the

Department of Electrical and Electronics Engineering

Department : **Electrical and Electronics Engineering**			Programme: **B.Tech.**						
Semester : **First**			Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	**Course Name**		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
EEUC101	**Elements of Electrical Engineering**		3	1	-	4	40	60	100
Prerequisite:	NIL								
Course Outcome: At the end of the course students will be able to	**CO1**	To understand the basic concepts of DC circuits and theorems.							
	CO2	To explain the concepts of AC circuits							
	CO3	To understand the basic concepts of Three Phase circuits							
	CO4	To understand electrical wiring and calculation of electrical energy.							
	CO5	To gain knowledge of electrical safety and protection Devices.							
UNIT-I	**DC Circuits**					**Periods: 12**			
Review of Ohm's and Kirchoff's Laws, Series and parallel circuits - Star Delta conversion - Mesh and Node Analysis of DC circuits- Network Theorems: Thevenin, Norton and Superposition.									**CO1**
UNIT-II	**AC Circuits**					**Periods: 12**			
Sinusoidal voltages and currents - average and R.M.S. values- peak factor and form factor for sinusoidal and non-sinusoidal waveform- phase difference- lagging- leading and in phase quantities and phasor representation -real power, reactive power, apparent power, power factor. Analysis of single-phase AC circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel).									**CO2**
UNIT-III	**Three Phase Circuits**					**Periods: 12**			
Concept of three-phase supply and phase sequence- voltages, currents and power relations in three phase balanced star-connected and delta-connected loads along with phasor diagrams– Power measurement by two Wattmeter method.									**CO3**
UNIT-IV	**Domestic Wiring**					**Periods: 12**			
Requirements: Connectors and switches, Types of wiring: casing and craping-Layout of an domestic wiring-Simple control circuit in domestic installation. Power rating of house holds appliances- calculation of electrical energy for domestic consumers.									**CO4**
UNIT-V	**Electrical Safety and Protective Devices**					**Periods:12**			
Electrical Safety: Safety precautions, electric shock, first aid for electric shock and other hazards, Use of multi-meters - Grounding: Definition, Importance of grounding, Types of grounding - Protective Devices: fuses, MCB, MCCB, ELCB and electromagnetic relays.									**CO5**
Lecture Periods: 45	**Tutorial Periods: 15**		**Practical Periods:-**				**Total Periods: 60**		

Reference Books:

1. Basic Electrical and Electronics Engineering by R.Muthusubramanian and S.Salivahanan. McGraw Hill Education India Pvt Ltd, New Delhi, 2009.
2. Electric Circuit Theory by Dr.M.Arumugam and N.Premkumar, Khanna Publisher, New Delhi, 2006.
3. B. L. Theraja, “Electrical Technology”, Vol.1, S. Chand Publication, New Delhi, 2014.
4. D C Kulshreshtha, “Basic Electrical Engineering”, Tata McGraw Hill, 2nd Edition, New Delhi, 2019.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3		-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Score: 3 – High; 2 – Medium; 1 – Low

Department : **Electrical and Electronics Engineering**		Programme: **B.Tech.**						
Semester : **Second**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	**Course Name**	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EEUC102	**Electronic Devices and Circuits**	3	1	-	4	40	60	100
Prerequisite:								
Course Outcome: At the end of the course Students will be able to	**CO1**	Analyze the construction, characteristics, and applications of semiconductor diodes and special-purpose diodes.						
	CO2	Examine the working principles and configurations of BJTs and FETs for amplification and switching applications.						
	CO3	Design and evaluate rectifier circuits, power supplies, and voltage regulation techniques using power semiconductor devices.						
	CO4	Interpret device datasheets and apply equivalent models to assess and design diode and transistor-based circuits.						
	CO5	Apply biasing methods and thermal management techniques to ensure stable operation of transistors and power devices.						
UNIT-I	**Semiconductor diodes**				**Periods: 12**			
PN junction diode - Construction – forward and reverse bias operation –volt-ampere characteristics mathematical model of a PN junction diode–Silicon versus Germanium diodes – Effects of temperature on diode operation– Static and dynamic resistances–Diode equivalent models– Specification sheets– Transition and diffusion capacitances–Diode switching characteristics -reverse recovery time, Diode applications: Clipping circuits – positive clipper, negative clipper and biased clipper. Clamping circuits – positive clamper, negative clamper and biased clamper.								**CO1, CO4**
UNIT-II	**Bipolar Junction Transistors**				**Periods: 12**			
Construction and operation– NPN and PNP transistors– CB, CE and CC configurations – Specification sheet, Transistor currents, current gains and leakage currents. BJT characteristics: Input and output characteristics of CB, CE and CC configurations and regions of operation Biasing of BJTs – DC load line characteristics - operating point– stabilization of operating point– different biasing circuits: base bias, base bias with emitter feedback, base bias with collector feedback and voltage divider bias and Bias compensation techniques–thermal stability and thermal runaway.								**CO2, CO4, CO5**
UNIT-III	**Field Effect Transistors**				**Periods: 12**			
Construction and operation of JFET – drain and transfer characteristics – JFET parameters - Shockley's equation– comparison between JFET and BJT. MOSFET – Construction and operation - depletion and enhancement types Biasing of FETs – Gate bias, source bias and potential divider bias.								**CO2**
UNIT-IV	**Power Devices and Rectifiers & Power Supplies**				**Periods: 12**			
Introduction to power devices– SCR, SCS, GTO, Shockley diode-DIAC- TRIAC and UJT. Half-wave rectifier and fullwave rectifiers: center tapped and bridge type – PIV and ripple factor calculations - ripple reduction using filter circuits: inductor filter, capacitor filter, LC filter and □ filter. Shunt and series voltage regulators – IC voltage regulators- Adjustable voltage regulators - Regulated power supplies.								**CO5**
UNIT-V	**Special Devices**				**Periods:12**			
Principle of operation of Schottky diode, Varactor diode, Zener diode, Tunnel diode and PIN Diodes. OPTO ELECTRONIC DEVICES: Principle of operation and characteristics of Photo diodes, Phototransistors, Photo conductive cells, LEDs and LCDs, Opto-couplers, seven segment displays, Solar cells and thermistors.								**CO1, CO3**
Lecture Periods: 45	**Tutorial Periods: 15**	**Practical Periods:-**			**Total Periods: 60**			

Reference Books:

1. Jacob Millman and Christopher C Halkias, Electronic Devices and Circuits, Tata-McGraw Hill, 2003.
2. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice-Hall India, 2009.
3. David A Bell, Electronic Devices and Circuits, PHI, 4thEdition, 2006.
4. J. D. Ryder, Electronic Fundamentals and Applications, Pearson Education, Canada, 1976.
5. Allen Mottershed, Electronic Devices and Circuits: An Introduction, PHI Learning, 2011

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO2	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO3	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO4	3	3	3	3	2	-	-	-	2	-	1	2	1	-
CO5	2	3	3	3	2	-	-	-	2	-	1	2	1	-

Score: 3 – High; 2 – Medium; 1 – Low