Scheme of Instruction, Evaluation

And

Syllabi of

With effect from Academic Year 2023-24

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

III & IV Semesters

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Esd.1917 **Hyderabad – 500 007, TS, INDIA** **Estd. 1929**

SCHEME OF INSTRUCTION AND EVALUATION

B.E. (Electrical and Electronics Engineering) w.e.f. 2023-24

III – Semester

S.No.	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	PC 301 EE	Electrical Circuits – I	3	-	-	3	3	40	60	3
2	PC 302 EE	Electrical Machines – I	3	-	-	3	3	40	60	3
3	PC 303EE	Electromagnetic Fields	3	-	-	3	3	40	60	3
4	PC 304 EE	Linear Integrated Circuits	3	-	-	3	3	40	60	3
5	PC 305 EE	Signals and Systems	3	-	-	3	3	40	60	3
6	PC 306 EC	Analog Electronics	3	-	-	3	3	40	60	3
Practicals										
7	PC 351 EE	Digital Electronics and Logic Design Lab	-	-	2	2	3	25	50	1
8	PC 352 EE	Linear Integrated Circuits Lab	-	-	2	2	3	25	50	1
9	PC 353 EC	Analog Electronics Lab	-	-	2	2	3	25	50	1
		Total	**18**	**-**	**6**	**24**	**27**	**315**	**510**	**21**

PC 301 EE	ELECTRICAL CIRCUITS – I					
			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

1. To acquire knowledge in electrical circuits and to understand the fundamentals of derived circuit laws.
2. To acquire knowledge in steady state analysts of single-phase AC circuits.
3. To understand network theorems.
4. To acquire knowledge in steady state analysts of three phase AC circuits.
5. To acquire knowledge in Transient analysis of circuits.

Course Outcomes:

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

1. Apply source transformation, star-delta transformation, and mesh & node analysis to analyze networks.
2. Evaluate steady state behavior of single-phase AC networks and design the series and parallel RLC circuits for the required bandwidth, resonant frequency and quality factor.
3. Analyze electric circuits using network theorems for AC and DC networks.
4. Evaluate steady state behavior of three-phase AC networks and analyze the coupled circuits.
5. Evaluate transient and steady response of networks for various excitations by solving differential equations.

Articulation matrix of Course Outcomes with POs:

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

.

UNIT I

Network Elements & Laws: Active elements, Independent and dependent sources. Passive elements — R, L and C, Energy stored in inductance and capacitance, Kirchhoff's laws, Source transformations, Star-delta transformations, Node voltage method, Mesh current method including super node and super mesh analysis.

UNIT II

Single-Phase Circuits: RMS and average values of periodic sinusoidal and non-sinusoidal waveforms, Phasor representation, Steady-state response of series, parallel and series-parallel circuits. Impedance, Admittance, Current locus diagrams of RL and RC series and parallel circuits with variation of various parameters. Resonance: Series and parallel circuits, Band-width and Q-factor.

UNIT III

Network theorems: Superposition theorem, Thevinin's theorem, Norton's theorems, Maximum power transfer theorem, Tellegen's theorem, Compensation theorem, Milliman's theorem and Reciprocity theorem. (AC & DC)

UNIT IV
Poly-phase Circuits: Analysis of balanced and unbalanced 3-phase circuits, Star and delta connections, Measurement of three-phase power for balanced and unbalanced loads. ***Coupled circuits:*** Concept of self and mutual inductance, Dot convention, Coefficient of coupling, Analysis of circuits with mutual inductance.
UNIT V
Transient analysis: Transient response of RLC circuits, Formulation of integral differential equations, Initial conditions, Response of RL, RC and RLC networks subjected to internal energy, Response to impulse, step, ramp, exponential and sinusoidal excitations.

Suggested Reading:
1. Van Valkenburg M.E., *Network Analysis*, Pearson education , 3rd Edition, 2019.
2. William Hayt H, Kimmerly Jack E, Steven Durbin M, *Engineering Circuit Analysis*, McGraw Hill, 7th Edition, 2006.
3. Jagan N.C, Lakshrninarayana C., *Network Analysis*, B.S. Publications, 3rd Edition, 2019.
4. Chakravarthy A., *Circuit Theory Analysis and Synthesis*, Dhanpat Rai & Co., Seventh Edition, 2018

PC 302 EE	ELECTRICALMACHINES– I					
			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

1. To learn and understand the principle of electromechanical energy conversion.
2. To be able to understand in detail about D.C Machines, construction, principle, performance characteristics and testing.
3. To be able to understand the D.C Generators, their types, characteristics and applications.
4. To be able to understand in detail about D.C Motors, performance curves, speed control methods, and various types of starters for DC motors and applications.
5. To obtain the power loss and calculate the efficiency of DC machines.

Course Outcomes:

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

1. Understand electromechanical energy conversion principle with singly and doubly exited magnetic systems
2. Understand construction, operating principle of DC Machines.
3. To be able to analyze the types, characteristics and applications of DC Generators and Motors
4. To be able to calculate performance parameters of DC Motors and their applications.
5. 5. To be able to analyze the power losses, calculate the efficiency and testing of D.C Machines.

Articulation matrix of Course Outcomes with POs:

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

.UNIT I

Electromechanical energy conversion: Principle of energy conversion, Flow of energy in electromechanical devices, Coupling-field reaction, singly excited magnetic system – Electric energy input, Magnetic field energy stored, Mechanical work done with slow, instantaneous and transient movement of armature, Calculation of mechanical force, doubly excited magnetic systems, electromagnetic and reluctance torques.

UNIT II

DC Machines: Simple loop generator, Essential parts of DC machine, Details of Lap winding& Wave winding, EMF equation, Armature reaction— Remedies, Ampere turns, Commutation — reactance voltage, Methods of improving commutation — High resistance brushes, shifting of brushes, inter poles, Compensating winding.

UNIT III

DC Generators: Classification & types of DC generators, Open circuit, Internal & External characteristics—Critical resistance & critical speed, Voltage regulation, Conditions for self-excitation, Causes of failure of voltage buildup, Parallel operation Series, Shunt and Compound generators, Applications.

UNIT IV
DC Motors: Classification &Types of DC motors, Back emf, Speed regulation, Armature torque, Armature reaction, Operating characteristics, Performance curves, Basic speed control methods Shunt and Series motors, Three & four-point starters, Calculation of step resistances, Applications
UNIT V
Testing, Losses and Efficiency: Power losses—Copper losses and Rotational losses, Power flow, Efficiency, Testing - Brake Test and Swinburne's test, Hopkinson's test, Field's test, Retardation test, Heat run test.

Suggested Reading:
1. D.P. Kothari, I.J. Nagrath, Electric Machines, Tata McGrawHill,4thEdition,2017
2. Bhimbra. P.S., Electrical Machinery, Khanna Publications,2021
3. Gupta J.B., Theory and Performance of Electrical Machines, S.K. Kataria &Sons, Delhi,2005.
1. 4. AE Clayton and NN Hancock, The Performance and Design of Direct Current Machines,3rdedition,1959.

PC 303EE	ELECTRO MAGNETIC FIELDS					
			L	T	P	C
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To be able to understand the concepts of electrostatic fields, magneto static fields.
2	To understand the concepts of electromagnetic wave propagation in different

Course Outcomes :	
On completion of this course, the student will be able to:	
CO-1	Understand the basic concept of electrostatic field and formulate problems with
CO-2	Derive expression for the energy stored in electrostatic field, electrostatic
CO-3	Understand the basic concept of magnetic field and formulate problems with the
CO-4	Derive expression for Maxwell's equations, energy stored in electric and magnetic field.
CO-5	Application of EM wave propagation and calculate the reflection and refraction coefficient of electromagnetic field

Articulation matrix of Course Outcomes with POs:

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

UNIT – I

Review of Vector Analysis: Coulomb's Law, Electric field intensity, Electric field due to different charge distributions. Electric field due to line charge, Sheet charge, Volume charge distribution, Electric flux density, Gauss's law, Divergence theorem. Potential, Potential gradient, Potential field of different charge distributions, Applications of above laws.

UNIT - II

Energy in electrostatic field, Poisson's and Laplace equations, Uniqueness theorem, Solution of Laplace's equation, Conductors, Conductor properties, Dielectric, Dielectric properties and Boundary conditions, Calculation of capacitance, Boundary conditions for conductors and perfect dielectric materials.

UNIT - III

Steady magnetic field, Biot-Savart's law, Ampere's law, Stoke's theorem, Magnetic scalar and vector potential, Faraday's law, Self and Mutual inductances, Force on moving charge, Force on differential elements, Magnetic boundary conditions, Magnetic circuits, Analogy with electrical circuits, Applications of above laws.

UNIT - IV

Maxwell's equations in Integral form, differential forms, Line and surface integrals, Boundary conditions, Continuity equation, Field equations in vector forms, energy storage in electric and magnetic fields.

UNIT - V

EM waves in homogeneous medium solutions for free space conditions, Uniform plane wave propagation, Poisson's and Laplace's equations, Sinusoidally time varying uniform plane waves in free space, Uniform plane waves in dielectrics and conductors, Poynting vector, Power dissipation, Reflection of uniform plane waves, Introduction to method of moments,

Suggested Reading:

1. Matthew Sadiku N.O., Elements of Electromagnetics, Oxford University Press, 7th Edition, 2018.
2. William. Hayt H, Buck John A., Engineering Electromagnetics, Tata McGraw Hill, 7th Edition, 2003.
3. Nannapaneni Narayana Rao, Elements of Engineering Electromagnetics, PHI, New Delhi, 5th Edition, 2002.
4. Matthew Sadiku N.O., Elements of Electromagnetics, Oxford University Press, 4th Edition, 2006.

PC 304 EE	LINEAR INTEGRATED CIRCUITS					
			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To introduce the basic building blocks of linear integrated circuits.
2	To understand the different linear and non-linear applications of op-amp.
3	To understand the voltage regulators and active filters by using op-amps.
4	To acquire the basic knowledge of special function ICs.
5	To understand the concepts of waveform generation using op-amps.

Course Outcomes :	
On completion of this course, the student will be able to:	
CO-1	Analyze the IC 741 operational amplifier and its characteristics.
CO-2	Design and use op-amps for various linear and non-linear applications
CO-3	Design and analyze multivibrator circuits using op-amp.
CO-4	Design and analyze the various applications of 555 timer.
CO-5	Design and use voltage regulators and active filters.

Articulation matrix of Course Outcomes with POs:

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

UNIT – I

Operational amplifiers: Characteristics, Open loop voltage gain, Output impedance, Input impedance, Common Mode Rejection Ratio, Offset balancing techniques Slew rate, Frequency response, Basic applications, Inverter summer, Analog integrator, Differentiator, Current to voltage converter, Voltage to current converter, Voltage follower, a.c. amplifier.

UNIT - II

Circuits using Op-amps: Voltage limiter, Clipper and damper, Precision rectifier-full wave and half wave, Peak detector, Comparator, Zero crossing detector, Schmitt trigger, Monostable, astable and bistable multivibrators, Multiplier, Divider, Difference amplifier, Instrumentation amplifier.

UNIT - III

Waveform generation using Op-amps: Sine, Square, Triangular and Quadrature oscillators, 555 timer - Functional diagram, Operation as monostable and astable, Voltage to frequency converter using 555, 565.

UNIT - IV

Voltage regulators using Op-amp: Series voltage regulators, Shunt regulators using Op-amp - Switching regulators using Op-amp, Buck, Boost, Buck-boost regulators, Regulators using IC 723, Dual voltage regulator, Fixed voltage regulators, Current sensing and current fold back protection.

UNIT - V

RC active filters: Butterworth, first order, second order for low pass, High pass, Band pass, Band reject, Notch, State variable filter, Switched capacitor filter, Universal filter, Power amplifiers, Power boosters, Monolithic power amplifier features.

Suggested Reading:

1. Roy Choudhury, Shail Jam - Linear integrated Circuits, New Age International, 2nd Edition, 2003.
2. Gayakwad W.A. Op-Amps and Linear Integrated Circuits, 4th Edition, Prentice Hall of India, 2002.
3. Malvino Albert Paul, Electronic Principles, 6th Edition, Tata McGraw Hill, 1999.
4. William D. Stanley, OP Amps with Linear Integrated Circuits, Pearson, 2000

PC 305 EE	SIGNALS AND SYSTEMS					
			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the classification of continuous-time and discrete-time signals
2	To develop ability to solve systems represented by differential equations and difference
3	To acquire the knowledge of representing the signals in frequency domain using Fourier series and Fourier transform.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of sampling and reconstruction and classify the continuous time signals and discrete time signals.
CO-2	Classify continuous and discrete time systems and understand how output is produced by convolution sum.
CO-3	Analyze continuous time systems with the help of Laplace transform and discrete time system with Z-transform.
CO-4	Analyze the continuous time signals in frequency domain using Fourier series and Fourier transform.
CO-5	Analyze the discrete-time systems in frequency domain with the help of Discrete Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT).

Articulation matrix of Course Outcomes with POs:

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

UNIT – I

Introduction to continuous time signals: Examples of signals and systems as seen in everyday life in relation to engineering and science. Signal properties: periodicity, absolute integrability, even and odd, causality, determinism and stochastic character. Energy signals and power signals. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals;

Introduction to discrete-time signals: Sampling and Reconstruction: The Sampling Theorem and its implications. Spectra of sampled signals. Aliasing and its effects. Reconstruction: ideal interpolator, zero-order hold and first-order hold. Classification of discrete time signals.

UNIT- II

Behavior of continuous and discrete-time LTI systems: System properties: linearity additivity and homogeneity, shift-invariance, causality and stability. Linear time invarian system, properties convolution integral and convolution sum. System representation through differential equations and difference equations.

UNIT- III

Laplace transforms: Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior.

Z - transforms: The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis and solution to difference equations., Lagrange's method of multipliers.

UNIT - IV

Frequency domain representation of continuous time signals: Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, properties, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality.

UNIT - V

Frequency domain representation of discrete time signals: The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Suggested Reading:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, ―Signals and systems, Prentice Hall India, third edition, 2007.
2. H. P. Hsu, ―Signals and systems, Schaum's series, McGraw Hill Education, 2010.
3. A. Anand Kumar, Signals and Systems‖, PHI learning PVT. LTD. Third edition, 2021.
4. B. P. Lathi, ―Linear Systems and Signals, Oxford University Press, 2009.

PC 306 EC	ANALOG ELECTRONICS					
			L	T	P	C
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the diode characteristics.
2	To study the input and out characteristics of different Transistor configurations.
3	To understand the design concepts FET and amplifier.
4	To understand the concepts of Feedback
5	To understand the Applications of Oscillators

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand the characteristics of diodes and, Rectifiers
CO-2	Design and analyze amplifier circuits
CO-3	To be able analyze characteristics of FETS and MOSFET.
CO-4	Analyzing of +ve and negative feedback circuits
CO-5	Design sinusoidal oscillators.

Articulation matrix of Course Outcomes with POs:

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

UNIT – I

Semiconductors & diodes: Energy bands, Intrinsic and Extrinsic Semiconductors, Mobility and Conductivity, Band structure of PN Junction, Volt – Amp Characteristics, Temperature Dependence, Transition and Diffusion Capacitance of PN Junction, Zener Diode, Diode circuits: Diode as a rectifier-Half-wave, Full-wave and Bridge Rectifiers, types of Filters, Capacitor and inductor filter, zener diode as a voltage regulator, Ripple Factor and Regulation Characteristics.

UNIT- II

Bipolar Junction Transistor: NPN and PNP junction Transistors, Transistor current components CB, CE and CC Configurations and their Characteristics, Saturation, Cutoff and Active Regions Comparison of CE, CB and CC Configurations, Maximum voltage rating, the operating point, fixed bias, emitter stabilized bias circuits, Voltage-divider bias, Stabilization, Thermal Runaway, Therma Stability, High frequency model of a Transistor. The h parameters of the three transisto configurations, Analysis of Transistor Amplifier Circuits using h–parameters.

UNIT- III

Field Effect Transistors: The Junction field effect transistor, Pinch off Voltage, Volt-ampere characteristics, Drain Saturation Current, Small Signal model of FET, MOSFET – Enhancement and Depletion Modes. The low Frequency common source and common drain amplifiers, FET biasing.

UNIT - IV

Feedback Amplifiers: Concept of Feedback, Feedback Amplifier Configurations, Circuits, Advantages of Negative feedback, Analysis of Simple feedback amplifiers using BJT and FET

UNIT - V

Barkhausen Criterion, RC Oscillators: Wien Bridge, Phase shift, LC Oscillators: Hartley and Colpitt's Oscillators, Crystal Controlled Oscillators (analysis of oscillators using BJTs only), stability of oscillators.

Suggested Reading:

1. Millman J., Halkias C.C. and Satyabrata Jit, Electronic Devices and Circuits, 3rd edition,Tata McGraw-Hill, 2011.
2. S Salivahanan, N Kumar, and A Vallavaraj, Electronic Devices and Circuits, 2nd ed., McGraw Hill Education, 2007.
3. Millman J., Halkias C.C. and Parikh C, Integrated Electronics, 2nd edition, Tata McGrawHill, 2009.
4. JB Gupta, Electronic Devices and Circuits, S.K Kataria & sons, 5th Edition, 2012

PC 351 EE	DIGITAL ELECTRONICS AND LOGIC DESIGN LAB					
			L	T	P	C
			-	-	2	1
Evaluation	**SEE**	50 Marks	**CIE**		25	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To verify the operations of various logic gates
2	To understand the concepts of code converters
3	To impart how to design the switching circuits
4	To learn about shift registers and counters
5	To know the function of analog-to-digital and digital-to-analog converters

Articulation matrix of Course Outcomes with POs:

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Identify and differentiate various logic gates
CO-2	Develop the combinational logic circuits
CO-3	Design and test the sequential logic circuits
CO-4	Realize the shift registers and counters using memory elements
CO-5	Analyze the various analog-to-digital and digital-to-analog converters

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

LIST OF EXPERIMENTS
1. Implementation of Truth Tables of various Logic Gates
2. Implementation of Logic Gates using Universal Gates
3. Implementation of Adders and Subtractors
4. Implementation of BCD to Excess- 3 Code Converter
5. Implementation of a 4-bit Shift Register
6. Implementation of a 4-bit Up Counter and Down Counter
7. Implementation of a 4-bit Synchronous and Asynchronous Counter
8. Implementation of a 4-bit Magnitude Comparator
9. Implementation of 8:1 Multiplexer and 2:4 De-Multiplexer
10. Implementation of Encoder and Decoder
11. Implementation of a 4-bit R-2R Digital-to-Analog Converter
12. Implementation of a 8-bit Successive Approximation Analog-to-Digital Converter

PC 352 EE	LINEAR INTEGRATED CIRCUITS LAB					
			L	T	P	C
			-	-	2	1
Evaluation	**SEE**	50 Marks	**CIE**		25	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the characteristics of operational amplifier
2	To acquire the basic knowledge of special function ICs
3	To apply operational amplifiers in linear and nonlinear applications
4	To gain the knowledge by conducting experiments on Op-amps, oscillators and timing circuits.
5	To use MATLAB software for circuit design.

Articulation matrix of Course Outcomes with POs:

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Design and analyze the various linear and nonlinear applications of op-amp.
CO-2	Analyze and design Clippers and Clampers using Op-Amps diodes
CO-3	Understand the applications of 555 timer
CO-4	Design and analyze oscillators and multivibrator circuits using op-amp.
CO-5	Design filters using Op-Amps.

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

LIST OF EXPERIMENTS
1. Inverting, Non-inverting and differential amplifiers.
2. Op-Amp applications - Integrator, differentiator, Adder& summer.
3. Clippers and Clampers using Op-Amp.
4. Generation of triangular and square wave using Op-Amp
5. Schmitt trigger circuit using op-amp.
6. Design Astable multivibrator using 555 Timer
7. Design monostable multivibrator using 555 Timer.
8. Study of 723 linear voltage regulator and fixed voltage regulator
9. RC phase shift oscillator using Op-Amp.
10. Active filters - Low pass filter & High pass filter.

PC 353 EC	ANALOG ELECTRONICS LAB					
			L	T	P	C
			-	-	2	1
Evaluation	**SEE**	50 Marks	**CIE**		25	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To study the working of CRO
2	To understand the characteristics of various Diodes
3	To know the working of rectifiers with/without filters for AC to DC conversion
4	To understand the input and output characteristics of different Transistor configurations of BJT and
5	To study the characteristics of different devices Oscillators

Articulation matrix of Course Outcomes with POs:

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Use CRO for various measurements like amplitude, frequency and phase of the
CO-2	Understand the working and applications of various diodes like Si, Ge and Zener
CO-3	Know the operation of various rectifiers with/without filters
CO-4	Understand the characteristics of BJT and FET
CO-5	Know the working of Feedback devices like oscillators

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

LIST OF EXPERIMENTS
1. Study of CRO: CRO for various measurements like amplitude, frequency and phase of the signals
2. VI characteristics of Semiconductor Diodes (Si & Ge), Forward Bias and Reverse Bias
3. Static Characteristics and voltage regulation of Zener Diode
4. Ripple and Regulation characteristics of Half-wave, Full-wave and Bridge rectifiers
5. Ripple and Regulation characteristics of Half-wave, Full-wave and Bridge rectifiers with Filters
6. Static Characteristics of CB Configuration of Transistor
7. Static Characteristics of CE Configuration of Transistor
8. Static and Transfer Characteristics of FET
9. RC phase shift oscillator
10. Wien bridge oscillator

SCHEME OF INSTRUCTION AND EVALUATION

B.E. (Electrical and Electronics Engineering) w.e.f. 2023-24

IV – Semester

S.No.	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	PC 401 EE	Electrical Circuits - II	3	-	-	3	3	40	60	3
2	PC 402 EE	Electrical Machines II	3	-	-	3	3	40	60	3
3	PC 403 EE	Power Systems - I	3	-	-	3	3	40	60	3
4	PC 404 EE	Linear Control Systems	3	-	-	3	3	40	60	3
5	PC 405 EE	Microprocessors and Microcontrollers	3	-	-	3	3	40	60	3
6	PC 406 EE	Electrical Measurements and Instrumentation	3	-	-	3	3	40	60	3
7	**Professional Elective – I**		3	-	-	3	3	40	60	3
	PE 411 EE	Electrical Distribution Systems								
	PE 412 EE	Renewable Energy Sources								
	PE 413 EE	Reliability Engineering								
Practicals										
8	PC 451 EE	Electrical Circuits Lab	-	-	2	2	3	25	50	1
9	PC 452 EE	Electrical Machines Lab – I	-	-	2	2	3	25	50	1
10	PC 453 EE	Microprocessors and Microcontrollers Lab	-	-	2	2	3	25	50	1
		Total	**21**	**-**	**6**	**27**	**30**	**355**	**570**	**24**

PC 401 EE	ELECTRICAL CIRCUITS – II					
			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

1. To acquire knowledge in Applications of Fourier series Fourier transform & Laplace transform to networks.
2. To acquire knowledge in two-port network parameters.
3. To understand the application of Graph theory.
4. To understand properties of network functions.
5. To understand the methods of electric network synthesis.

Course Outcomes:

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

1. Evaluate the behavior of networks using Fourier series, Fourier transform & Laplace transforms.
2. Obtain two port network parameters and applications of graph theory to electric circuits.
3. Apply graph theory to electric circuits.
4. Test the given function for Positive real function.
5. Synthesize a network in terms of RL, RC and RLC parameters.

Articulation matrix of Course Outcomes with POs:

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

UNIT I
Fourier Series and Integral: Review of Fourier series and Fourier Transforms, Application of Fourier series and Fourier transforms to simple networks. ***Laplace Transform Method of Analysis of Networks:*** Laplace properties and theorems, Waveforms synthesis, Partial fraction method of inverse transforms, Application to networks, Transfer functions.
UNIT II
Two port network parameters: Open circuit impedance parameters, Short circuit admittance parameters, Transmission parameters, Hybrid parameters, conditions for Reciprocity and Symmetry, Inter-relationships between different sets of parameters, Interconnection of two port networks: Series, parallel and cascade connection.

UNIT III
Topological Description of Networks: Graph, tree, chord, cut-set, incident matrix, circuit matrix and cut-set matrix, Formulation of network equations, Node voltage equations, loop current equations, cut-set equations for RLC networks.
UNIT IV
Network synthesis: Driving point impedance and admittance functions, Concept of Poles and zeros in a network function, Positive real function, Properties of Positive real functions, Testing of Positive real functions, Hurwitz polynomial.
UNIT V
Network synthesis: Basic operations in synthesis, Properties of LC, RC and RL networks, Properties of networks in terms of poles and zeros, Synthesis of LC, RC, RL functions, Foster forms, Cauer forms, Properties of RLC networks, Synthesis of RLC networks.

Suggested Reading:
1. Van Valkenburg M.E., *Network Analysis*, Pearson education, 3rd Edition, 2019.
2. William Hayt H, Kimmerly Jack E, Steven Durbin M, *Engineering Circuit Analysis*, McGraw Hill, 7th Edition, 2006.
3. Jagan N.C, Lakshrninarayana C., *Network Analysis*, B.S. Publications, 3rd Edition, 2019.
4. Chakravarthy A., *Circuit Theory Analysis and Synthesis*, Dhanpat Rai & Co., Seventh Edition, 2018
5.Samrajith Ghosh, *Network theory Analysis and Synthesis*, PHI Learning private limited, first edition , 2005

PC 402 EE	**ELECTRICAL MACHINES -II**					
			L	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:

The course is taught

1	To be able to understand in detail about transformers and induction machines. Construction, principle, performance characteristics and testing.
2	To understand the construction, principle and performance characteristics of fractional HP Motors
3	To understand the type of connections of 3-phase transformers, constructional features of transformers and parallel operation of transformers.
4	To be able to understand the starting methods and speed control methods of 3-
5	To understand the principle of operation of Induction Generator.

Course Outcomes:

On completion of this course, the student will be able to:

CO-1	Acquire the knowledge of construction, principle of operation and testing of single-phase transformers.
CO-2	Impart the knowledge about three phase transformers, three phase to two phase
CO-3	Acquire the knowledge about the constructional details, equivalent circuit parameters
CO-4	Acquire the knowledge about starting and speed control methods of three phase
CO-5	Impart the knowledge of constructional details, principle of operation and types of

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO
CO1	2		1	-	1	1	-	-	-	-	1	-	1	1
CO2	2	1	1	1	1	1	-	-	-	-	1	1	1	1
CO3	2	1	1	1	1	1	-	-	-	-	1	-	1	1
CO4	2	1	1	1	1	1	-	-	-	-	1	-	1	1
CO5	2	1	1	1	1	1	-	-	-	-	1	-	1	-

UNIT – I
Single Phase Transformers: Constructional features of single phase transformers, principle of two winding transformer, ideal transformer - transformer on no load and on load – phasor diagrams- equivalent circuits, losses, Testing - Polarity test, OC and SC tests, Sumpner's test, Regulation and efficiency, All day efficiency, separation of losses - Excitation phenomena in transformers, Auto transformer - Comparison with two winding transformer and applications.
UNIT – II
Three - Phase Transformers: Connections - Choice of transformer connections – Third harmonic voltages - Phase conversion - 3-phase to 2-phase transformation, Scott connection – constructional features of poly phase transformers - Tertiary winding, Parallel operation of transformers, phase shifting transformer, Tap changer.
UNIT – III
Three - Phase Induction Motor: Constructional features - Rotating magnetic field theory, Principle of operation of Squirrel cage and Slip ring motors, Phasor diagram, Equivalent Circuit – expression for torque - starting torque - Max torque. Slip-torque characteristics, Equivalent circuit parameters from no-load and blocked rotor test, Circle diagram, Determination of performance characteristics of induction motor, Applications
UNIT – IV
Starting & Speed Control Methods: Starting methods of 3-phase induction motor –Auto transformer, Star-delta Starter. Double cage machine, Speed control methods – Resistance control, Voltage Control, Pole changing, Cascading, Induction Generator - Principle of operation, Applications
UNIT – V
Single Phase Motors: Double field revolving theory. Equivalent circuit of single-phase induction Motor- Principle of operation, speed torque characteristics of a split phase and capacitor motors. Compensated and uncompensated series motor, Repulsion motor and universal motor Applications

Suggested Reading:

1	P.S. Bimbhra- Electrical Machinery, Khanna Publishers 2006
2	D.P. Kothari & I.J. Nagrath, Electrical Machines, Tata McGraw Hill, 4th Edition, 2010.
3	M.G.Say - The Performance and Design of AC. Machines Pitman Publication, 2002.
4	Irving L. Kosow - Electric Machinery and Transformers. PPH, Pearson Education, 2nd Edition,2009

PC 403 EE	POWER SYSTEMS – I					
			L	T	P	C
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student:	
1	To introduce the economic aspects of power generation and tariff methods and understand the concepts of A.C. and D.C. distribution.
2	To understand the working of conventional power plants like Thermal, Hydel and Nuclear.
3	To understand the basic working principles of renewable power plants like Solar, Wind and Gas Turbine power plants.
4	To understand about various overhead line components and cables.
5	To familiarize with transmission line parameter calculations.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Evaluate various economic aspects of power generation like depreciation fund calculations and Tariffs and perform A.C. and D.C. distribution calculations.
CO-2	Understand the operation of conventional power plants.
CO-3	Understand the basic working principle of renewable power plants like Solar, Wind, and Gas turbine plants.
CO-4	Evaluate the performance of overhead line insulators and underground cables and to perform sag calculations.
CO-5	Determine the electrical circuit parameters of transmission line.

Articulation matrix of Course Outcomes with POs:

Course Outcome	**Program Outcome**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO-1	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO-2	3	2	1	-	-	-	2	-	-	-	-	2	3	-
CO-3	3	2	1	-	-	-	2	-	-	-	-	3	3	-
CO-4	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO-5	3	3	3	-	-	-	-	-	-	-	-	-	3	-

Correlation rating**:** **Low / Medium / High – 1 / 2 / 3** respectively

UNIT – I
Economics of Power Generation: Load Curve, Load Demand and Diversified factors, Base Load and Peak load operation, Types of costs and depreciation fund calculations, Methods of power factor improvement, Economics of power factor improvement, Tariffs, Distribution: 2 wire and 3 wire distributors, Ring mains, AC distribution calculations.
UNIT – II
Steam Power Stations: Choice of site, Layout & various parts of station, Boilers, Turbines, Super Heaters, Economizers, Air pre-heaters etc. and their Pulverized fuel, Coal handling. **Hydro-Electric Power plants:** Estimation Hydrograph, Flow duration curve, Mass curve, Storage and pondage, Types electric plants and layouts, Prime movers for hydroelectric plants.
UNIT – III
Nuclear Power Plants: Fissile materials, working principle of nuclear plants and reactor control, Shielding, Types of reactors. **Non-Conventional Energy Sources:** Basic principles of Wind, solar and gas turbines.
UNIT – IV
Over-Head Lines: Supports sag and tension calculations, Effect of wind and ice, Erection conditions, Insulators: Types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, Testing of insulators. **Insulated Cables:** Conductors for cables, Insulating materials, Mechanical protection, Low voltage cables, Grading of cables, Three phase high voltage cables and Super voltage cables, Capacitance of three-core cables.
UNIT – V
Inductance and Capacitance of Transmission Lines: Inductance and capacitance of overhead line conductors, Single phase and three phase with symmetrical composite conductors, GMR and GMD Spacing, Transposition, Bundled conductors, Effect of earth capacitance.

Suggested Reading:

1	Wadhwa C.L., *Electrical Power Systems*, New Age International (P) Ltd., 8th Edition, 2022.
2	Wadhwa C.L., *Generation, Distribution and Utilization of Electrical Energy*, New Age International (P) Ltd., 4th Edition, 2017.
3	Singh S.N., *Electrical Power Generation*, Transmission and Distribution, Prentice Hall of India, Pvt. Ltd., New Delhi, 2nd Edition, 2008.
4	V.K. Mehta, *Principles of Power Systems*, S. Chand and Co., 7th Edition, 2021.

PC 404 EE	LINEAR CONTROL SYSTEMS					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To develop basic skills of utilizing mathematical tools needed to analyze and design classical linear control systems.
2	To understand and develop the state space representation of control systems.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Develop Mathematical modeling of Electrical and Mechanical systems.
CO-2	Determine Transient and Steady State behavior of systems using standard test
CO-3	Analyze the system in time domain using Routh's stability criterion and root locus.
CO-4	Analyze the system in frequency domain using Nyquist stability criterion and Bode plot. Design controllers to meet desired specifications.
CO-5	Develop state space models for control systems.

Articulation matrix of Course Outcomes with POs:

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO 10	PO 11	PO 12	PSO	PSO
CO	3	2 3	2 3	2 4	5 -	2 6	7 -	8 -	9 -	-	-	2	1 2	2
CO 1	3	3	2	2	-	2	-	-	-	-	-	2	2	2
CO 2	3	3	3	3	-	2	-	-	-	-	-	2	2	2
CO	3	3	3	3	-	2	-		-			2	2	2
CO 5	3	3	2	3	-	2	-	-	-	-	-	2	2	2

Correlation rating: Low/Medium/High: 1/2/ 3respectively.

UNIT –I
Introduction to Control Systems: Classification of control systems. Feed-Back Characteristics, Effects of feedback - Mathematical modeling of Electrical and Mechanical systems -Transfer function- Transfer function of Potentiometer, synchro, AC servo motor, DC servo motor - Block diagram reduction technique - Signal flow graph, Mason's gain formula

UNIT- II
Time Domain Analysis: Standard test signals - Time response of first order systems - Transient response of second order system for unit step input, Time domain specifications - Steady state response - Steady state errors and error constants - Effects of P, PD, Pl and PID controllers on system performance.

UNIT- III
Stability Analysis in S-Domain: The concept of stability - Routh's stability Criterion, Absolute stability and relative stability- limitations of Routh's stability. **Root Locus Technique**: The root locus concept - construction of root loci- Effects of adding poles and zeros on the root loci.

UNIT -IV
Frequency Response Analysis: Introduction to frequency response - Frequency domain specifications - Bode plot - Stability analysis from Bode plots - Determination of transfer function from the Bode Diagram - Polar Plots, Nyquist Plots, Stability Analysis, Gain margin and phase margin. ***Control System Design:*** Introduction - Lag, Lead and Lag-Lead Compensator design in frequency Domain.

UNIT - V
State Space Analysis: Concepts of state, State variables and state model, Derivation of state models of linear time invariant systems - Controllable, Observable and Diagonal state models - State transition matrix - Solution of state equation - Concepts of Controllability and Observability.

	Suggested Reading:
1	Nagrath I.J. & Gopal.M - Control System Engineering, Wiley Eastern, 2003.
2	B.C.Kuo - Automatic Control Systems, Wiley India edition, 7th Edition, 2002.
3	K.Ogata - Modern Control System, Prentice Hall of India, 4th edition, 2002.
4	N.C.Jagan - Control Systems, B.S Publications, 2nd edition,2008.
5.	S.Palani, Anoop K Jairath - Automatic Control System, Ane books Pvt. Ltd, 2013
6.	A. Anand Kumar, Control Systems, PHI Learning Private Limited, 2011

PS 405 EE	MICROPROCESSORS AND MICROCONTROLLERS

Pre-requisites		L	T	P	C
		3	-	-	3
Evaluation	**SEE** 60 Marks	**CIE**		40Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To understand about 8086 microprocessor architecture and its different features.
2	To know Instruction set and addressing modes of 8086 and writing assembly
3	To know the use of interfacing devices and process of interfacing.
4	To understand about 8051 microcontroller architecture and its different features.
5	To know Instruction set and addressing modes of 8086 and writing assembly

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Acquire the knowledge of Architecture of 8086, interrupts, timing diagrams.
CO-2	Write assembly language programs of 8086 for a given task.
CO-3	Interface memory and I/O devices to 8086 using peripheral devices.
CO-4	Acquire the knowledge of 8051 Micro controller and its resources.
CO-5	Write assembly language programs of 8051 for a given task.

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	1	1	-	1	-	-	-	-	-	3	-	2
CO 2	3	3	3	2	3	2	-	-	-	-	-	3	-	2
CO 3	3	3	3	3	-	2	-	-	-	-	-	3	-	2
CO 4	3	1	1	1	-	1			-			3		3
CO 5	3	3	3	3	3	2	-	-	-	-	-	3	-	3

Correlation rating: Low/Medium/High: 1/2/ 3respectively.

UNIT –I
Microprocessor: Evolution of Microprocessors, Internal architecture of 8086 - Segmented memory, Registers, Pin diagram of 8086 in minimum and maximum mode configuration - Timing diagram of typical read write instructions - Interrupts, Steps in interrupt process, Interrupt structure in 8086, Internal and externalinterrupts-interrupt service routines.
UNIT- II
Introduction to Programming : Instruction set and addressing modes of 8086,Assembly language programming, Assembler directives, Simple programs using assembler.
UNIT- III
Interfacing the Microprocessor : Memory and I/O interfacing, , 8255(PPI), Programmable Internal Timer (8253), Programmable Interrupt Controller (8259), Matrix Key board, Seven segment display , A/D and D/A interfacing. **Serial interface and data converters:** USART 8251, Serial interface standards-RS 232 C andRS -485.
UNIT -IV
Micro Controller Architecture : Types of Micro Controllers, 8051 Micro Controller - Internal architecture, Pin diagram, Memory organization, Parallel I/O Ports, Timer/Counters, Serial data interface and , Interrupts & timers.
UNIT - V
Introduction to Programming : Instruction set and addressing modes of 8051, Classification of instructions, Simple assembly language programs, Interfacing using 8051.

Suggested Reading:

1	Douglas. V. Hall, Microprocessors and Interfacing -Tata McGraw Hill -Revised 2nd Edition, 2005.
2	Krishna Kant -Microprocessors and Microcontrollers - Architecture, Programming and System Design 8085, 8086, 8051, 8096, Prentice-Hall India - 2007.
3	Kenneth. J. Ayala – “The 8051 Microcontroller Architecture Programming and Applications", Thomson publishers, 2nd Edition, 2007.
4	Waiter A. Triebel& Avtar Singh - The 8088 and 8086 Microprocessor -Pearson Publishers, 4th Edition, 2007.
5	Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin McKinlay ‘The 8051 Microcontroller andEmbedded Systems using Assembly and C’, Prentice Hall Publications, 2nd Edition, 2008.

PS 406 EE	Electrical Measurements and Instrumentation					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To learn and understand the fundamental concepts, principle of operation and applications
2	To understand various types of Bridges in measurement of resistance, inductance,
3	To understand the operation and applications of Ballistic Galvanometer, Flux meter and DC/AC Potentiometer.
4	To understand the application of CRO for measurement of Amplitude, Phase and

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Choose the suitable instrument like Ammeter, Voltmeter for AC/DC applications
CO-2	Select suitable Bridge for measurement of electrical parameters and quantities
CO-3	Use of CRO for the measurements

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	1	1	-	1	-	-	-	-	-	3	-	2
CO 2	3	3	3	2	3	2	-	-	-	-	-	3	-	2
CO 3	3	3	3	3	-	2	-	-	-	-	-	3	-	2
CO 4	3	1	1	1	-	1			-			3		3
CO 5	3	3	3	3	3	2	-	-	-	-	-	3	-	3

Correlation rating: Low/Medium/High: 1/2/ 3respectively.

UNIT –I

Instruments: indicating, Recording and Integrating instruments, Ammeter, Voltmeter, Expression for torque of moving coil, moving iron, Dynamometer, induction and electrostatic instruments. Extension of range of instruments, Wattmeter Torque expression for dynamometer instruments, Reactive power measurement.

UNIT- II

Meters: Energy meters, single phase and 3-phase, Driving torque and braking torque equations, Errors and testing compensation, Maximum demand indicator, Power factor meters, Frequency meters, Electrical resonance and Weston type of synchroscope.

UNIT- III

Bridge Methods and transducers: Measurement of inductance, capacitance and resistance using Bridges, Maxwell's, Hay's. bridge, Anderson, Wein, Desauty's, Schering's bridges, Kelvin's double bridge, Megger, Loss of charge method, Wagner's earthing device, Transducers - Analog and digital transducers, Strain gauges and Hall effect transducers.

UNIT -IV

Magnetic Measurements and instrument transformers: Ballistic galvanometer, Calibration by Hibbert' s magnetic standard flux meter, Lloyd-Fischer square for measuring iron loss, Determination of B-H curve and Hysteresis loop using CRO, Instrument transformers – Current and potential transformers, ratio and phase angle errors of CT's and PT's.

UNIT - V

Potentiometers: Crompton's DC and AC polar and coordinate types, Applications, Measurements of impedance, Calibration and ammeter voltmeter and wattmeter. Use of oscilloscope in frequency, phase and amplitude measurements

Suggested Reading:

1	Shawney A.K., Electrical and Electronics Measurements and Instruments, Dhanpatrai & Sons, Delhi, 2000.
2	Umesh Sinha, Electrical, Electronics Measurement & Instrumentations, Satya Prakashan, New Delhi.
3	Golding E.W., Electrical Measurements & Measuring Instruments, Sir Issac& Pitman & Sons Ltd., London.
4	U.A.Bakshi, A.V.Bakshi, Electrical and Electronic Instrumentation, Technical publications

PE 411 EE	ELECTRICAL DISTRIBUTION SYSTEMS					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student:	
1	To understand the economic aspects in a distribution system.
2	To get familiarized with different components like sub-transmission lines, sub-stations, and feeders.
3	To understand the types of distribution systems and their working.
4	To have an idea of analysis and control of distribution systems.
5	To understand the importance of power quality and applications of capacitors in distribution system.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understand the basic concepts of load characteristics and rate structure.
CO-2	Evaluate the sub-transmission lines and distribution substation ratings.
CO-3	Understand the primary and secondary distribution systems and their
CO-4	Evaluate the voltages and power losses of the distribution system using different methods.
CO-5	Determine the optimal location of the capacitor in the distribution system and acquire knowledge of distribution automation.

Articulation matrix of Course Outcomes with POs:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO-1	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-2	3	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-3	3	3	1	-	-	-	-	-	-	-	-	2	2	-
CO-4	3	3	2	-	-	-	-	-	-	-	-	2	3	-
CO-5	3	3	3	2	2	-	-	-	-	-	-	2	3	-

Correlation rating**:** **Low / Medium / High – 1 / 2 / 3** respectively

UNIT – I
Introduction, Load characteristics. Diversified demand. Non- coincidence demand. Coincidence factor, contribution factor Problems. Rate structure, customer billing, types of distribution transformers.
UNIT – II
Design of Sub-transmission lines and distribution sub-stations. Substation bus schemes, rating of distribution substation, service area with multiple feeders, percent voltage drop Calculations.
UNIT – III
Design considerations of primary systems, radial type, loop type primary feeder, primary feeder loading, uniformly distributed load application to a long line. Design considerations of secondary systems. Secondary banking. Secondary networks. Network transformers, unbalanced loads and voltages.
UNIT – IV
Voltage and power loss calculations - Non 3-Phase primary lines – Single phase two wire laterals with ungrounded neutral, Single phase two wire ungrounded neutral, Single phase two wire laterals with multi-grounded common neutrals, Two phase plus neutral laterals. Voltage fluctuations, measures to reduce flickering, Methods of load flow of Distribution Systems – forward sweep and backward sweep methods.
UNIT – V
Application of capacitors to distribution systems. Effect of series and shunt capacitors, power factor correction, economic justification for capacitors. Best capacitor location-Algorithm. Distribution Automation: Definitions, Components of distribution SCADA.

Suggested Reading:

1	Turan Gonen, Electric Power Distribution Engineering, CRC Press., 3rd Edition. 2014.
2	A.S. Pabla, Electric Power Distribution, Tata McGraw Hill Publishing Company Ltd., 6th Edition, 2012.
3	V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 2nd edition, 2010.

PE 412 EE	RENEWABLE ENERGY SOURCES					
			L	T	P	C
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student:	
1	To understand the concepts and Importance of renewable energy sources such as solar, wind, biomass, tidal power and fuel cell systems
2	To make the students understand the different applications of renewable

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Differences of different energy sources and learn about the working principles na d applications of fuel cell technology
CO-2	Acquire the knowledge of solar geometry and solar systems
CO-3	Acquire the knowledge of wind energy systems
CO-4	Acquire the knowledge of ocean thermal and geothermal energy systems
CO-5	Acquire the knowledge of bio-mass energy systems

Articulation matrix of Course Outcomes with POs:

Course Outcome	**Program Outcome**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO-1	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO-2	3	2	1	-	-	-	2	-	-	-	-	2	3	-
CO-3	3	2	1	-	-	-	2	-	-	-	-	3	3	-
CO-4	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO-5	3	3	3	-	-	-	-	-	-	-	-	-	3	-

Correlation rating**:** **Low / Medium / High – 1 / 2 / 3** respectively

UNIT – I
Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells — Polarization - Conversion efficiency and Applications of Fuel Cells.
UNIT – II
Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.
UNIT – III
Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations - Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects
UNIT – IV
Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo-thermal Energy Systems - Applications of Geo-thermal Energy.
UNIT – V
Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass - Biomass gasifiers.

Suggested Reading:

1	Rai G.D, Non-Conventional Sources of Energy, Khandala Publishers, New Delhi, 1999.
2	M.M.El-Wakil, Power Plant Technology. McGraw Hill, 1984.
3	John Twidell, Tony Weir, Renewable Energy Resources, 3rd Edition, Taylor and Francis.

PE 413 EE	RELIABILITY ENGINEERING					
Pre-requisites	Mathematics III/ Probability		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To comprehend the basics of probability distributions & reliability models.
2	To model systems with series-parallel block diagrams and state-space diagrams and
3	To understand multi-mode failures of electrical & electronic circuits and their effect on reliability & availability.
4	To understand reliability & availability models for generation, composite generation and transmission systems.
5	To understand the distribution system & application to radial systems, parallel, mesh networks and methods to evaluate reliability indices.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Able to relate the probability concepts and distributions in reliability engineering
CO-2	Able to draw reliability logic diagram and state-space diagram of engineering systems to evaluate reliability and availability
CO-3	Apply multi-mode failures in electrical and electronic circuits
CO-4	Evaluate the risk indices related to generation and transmission
CO-5	Evaluate various reliability indices related to distribution systems

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	3	2	3	1	2	1	-	-	-	-	1	3	-
CO 2	3	3	2	3	1	2	1	-	-	-	-	1	3	-
CO 3	3	3	2	3	1	2	1	-	-	-	-	1	3	-
CO 4	3	3	2	3	1	2	1	-	-	-	-	1	3	-
CO 5	3	3	2	3	1	2	1	-	-	-	-	1	3	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT – I
Discrete & Continuous random variables – Binomial, Exponential &Weibull distributions – Causes of failure – Failure rate & Failure density – Bath tub curve – Reliability & MTTF – Maintainability & Availability – MTBF & MTTR – Reliability block diagram – Series & Parallel systems – Conditional probability - Minimal Cut set & Tie-set methods

UNIT - II
Continuous Markov models – State space diagram - Reliability models of single unit, two unit & standby systems – Reliability & Availability models with repair – Frequency of failures – State transition matrix and estimation of MTTF

UNIT - III
Multi-mode failures - Short circuit & open circuit failures - Resistors & capacitors in series & parallel - Diodes & MOSFETs in series & parallel - Quad system - Reliability Prediction - MIL standards - Parts count technique - Parts stress technique - Reliability, Availability and MTTF evaluation of Power electronic circuits

UNIT - IV
Outage definitions – Markov model of Generating plant with identical and non-identical units – Capacity Outage probability table – Cumulative frequency – LOLE – Composite Generation & Transmission systems - Radial configuration – Conditional probability approach

UNIT - V
Customer oriented, load oriented & energy oriented indices of distribution system – Application to radial systems – Effects of lateral distributer protection, disconnects, protection failures & transferring loads s – Parallel & Mesh networks – Dual transformer feeder – Approximate, Network reduction & FMEA methods

Suggested Reading:

1	Roy Billinton, R.N. Allan, 'Reliability Evaluation of Engineering Systems', Springer International Edition, Plenum Press, New York, 1992
2	E. Balaguruswamy, 'Reliability Engineering', Tata McGraw Hill Education Pvt. Ltd., 2012
3	Charles E. Ebeling, 'An Introduction to Reliability and Maintainability Engineering', McGraw Hill International Edition, 1997
4	L. Umanand, 'Power Electronics: Essentials & Applications', Wiley, 2009
5	Roy Billinton, R.N. Allan, 'Reliability Evaluation of Power Systems', Springer, 1st Edition, Plenum Press, New York, 1996.

PC 451 EE	ELECTRICAL CIRCUITS LAB					
			L	T	P	C
			-	-	2	1
Evaluation	SEE	50 Marks	CIE		25 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To Train the Students for acquiring practical knowledge in time response and frequency response of series / parallel RC, RL and RLC Circuits.
2	To prepare the students for finding out parameters of a given two port networks
3	To make the students for understanding the verification of theorems.
4	To Train the Students for acquiring practical knowledge single phase AC circuits
5	To Train the Students for acquiring practical knowledge three phase AC circuits

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Evaluate the time response characteristics of R, L, C Circuits.
CO-2	Evaluate the frequency response characteristics of R,L,C Series and parallel Circuits
CO-3	Validate the network theorems.
CO-4	Find various parameters of a two-port network.
CO-5	Obtain power using two-wattmeter method

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	1	1	-	1	-	-	2	3	-	3	-	2
CO 2	3	3	3	2	3	2	-	-	2	3	-	3	-	2
CO 3	3	3	3	3	-	2	-	-	2	3	-	3	-	2
CO 4	3	1	1	1	-	1			2	3		3		3
CO 5	3	3	3	3	3	2	-	-	2	3	-	3	-	3

Correlation rating: Low/Medium/High: 1/2/ 3respectively.

List of Experiments
1. Charging and Discharging Characteristics of RC series circuits. 2. Locus diagrams of RC and RL Circuits. 3. Study of single phase RLC circuits. 4. Frequencies Response of a Series RLC Circuits. 5. Frequencies Response of a Parallel RLC Circuits. 6. Parameters of two port network. 7. Series, parallel and cascade connection of two port networks. 8. Verification of Theorems. (a) Thevenin's theorem (b) Norton's theorem (c) Superposition theorem 9. Verification of Theorems.

PC 452 EE	ELECTRICAL MACHINES LAB – I					
			L	T	P	C
			-	-	2	1
Evaluation	**SEE**	50 Marks	**CIE**		25 Marks	

Course Objectives :

The course is taught with the objectives of enabling the student to:

1	To learn operation and performance characteristics of d.c machines by conducting various experimentsand tests practically
2	To understand the operation and performance characteristics of transformers by conducting variousexperiments and tests
3	To estimate the efficiency of DC Machine by separation of losses using suitable tests practically.
4	To calculate the efficiency of Transformer by conducting No Load and Short-circuit test's practically
5	To Analyze the connections of three-phase transformer

Course Outcomes:

On completion of this course, the student will be able to:

CO-1	Estimate the efficiency and voltage regulation of D.C. generator and transformers
CO-2	Acquire the knowledge of efficiency and speed regulation D.C. Motors under various conditions loading conditions.
CO-3	Able to understand the speed control of DC motor by conducting different experiments
CO-4	To be able to calculate the various parameters of machine and transformers by conducting suitable testing
CO-5	To be able to calculate the various parameters of three-phase transformers by using three phase transformer connections

Articulation matrix of Course Outcomes with POs:

PO`s / Outcomes	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PS02
C01	3	-	-	3	-	-	-	-	2	-	-	-	-	-
C02	3	-	-	3	-	-	-	-	2	-	-	-	-	-
C03	2	-	-	3	-	-	-	-	2	-	-	-	-	-
C04	2	2	-	3	-	-	-	-	2	-	-	-	-	-
C05	2	2	-	3	-	-	-	-	2	-	-	-	-	-

Correlation rating: Low/Medium/High: 1/2/ 3respectively.

LIST OF EXPERIMENTS

1. Magnetization characteristics of a separately excited D.C. generator.
2. Determination of the load characteristics of shunt and compound generators.
3. Determination of the performance and mechanical characteristics of series, shunt and compound motors.
4. Separation of iron and friction losses and estimation of parameters in D.C. machine.
5. Speed control of D.C. Shunt motor using shunt field control and armature control methods.
6. Separation of core losses in a single-phase transformer.
7. Open circuit and short circuit and load test on a single-phase transformer.
8. Sumpner's test on two identical transformers.
9. Three phase Transformer connections.
10. Three phase to two phase transformation and open delta connection.
11. Retardation test.
12. Hopkinson's test.
13. Swinburne's test.

PC 453 EE	MICROPROCESSOR AND MICROCONTROLLERS LAB					
			L	T	P	C
			-	-	2	1
Evaluation	SEE	50 Marks	CIE		25 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To provide solid foundation in assembly language programming of 8086 Micro processor and 8051 Micro controller.
2	To provide the knowledge of interfacing the external devices to the Microprocessor and Micro controller according to the user requirements to create novel products and solutions for the real time problems.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Familiarize with the instruction set of 8086.
CO-2	Write programs for given task using different addressing modes.
CO-3	Interface various I/O devices using 8255 PPI and 8051.
CO-4	Understand the instruction set of 8051 and its application.
CO-5	Write the assembly language programs of microcontroller for a given

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	1	1	-	1	-	-	2	3	-	3	-	2
CO 2	3	3	3	2	3	2	-	-	2	3	-	3	-	2
CO 3	3	3	3	3	-	2	-	-	2	3	-	3	-	2
CO 4	3	1	1	1	-	1			2	3		3		3
CO 5	3	3	3	3	3	2	-	-	2	3	-	3	-	3

Correlation rating: Low/Medium/High: 1/2/ 3respectively.

8086 assembly language programs
1. Programs to transfer data from one memory location to another location. 2.Signed/unsigned addition, subtraction, multiplication and division. 3. Finding average, largest, square root, etc., 4. Sorting set of numbers. 5. Code conversion like BCD numbers into binary. 6. 8255 PPI for interfacing LEDs. 7. 8255 PPI for interfacing to generate triangular wave using DAC.
8051 assembly language programs
1. Data transfer – block move, exchange, sorting, finding largest element in array. 2. Arithmetic instructions: addition, subtraction, multiplication and division. 3. Boolean & logical instructions (Bit manipulations). 4. Programs to generate delay, programs using serial port and on chip timer/counter. 5. Use of JUMP and CALL instructions. 6. Square wave generation using timers. 7. Interfacing of keyboard and 7-segment display module. 8. DAC interfacing for generation of sinusoidal wave.